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(71)Applicant : **PIONEER ELECTRONIC CORP**

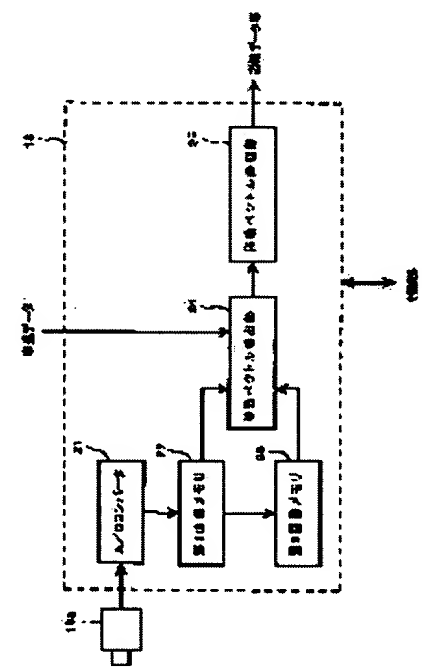
(72)Inventor : **KASHIWAZAKI TAKASHI**

(54) DEVICE AND METHOD FOR IMAGE PROCESSING AND NAVIGATION DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an on-vehicle image processor and an on-vehicle navigation device which maintain the safety of a traveling vehicle and can also acquire road width data by imaging sides from the traveling vehicle and performing image processing.

SOLUTION: An image signal from a CCD camera 19a imaging sides of a vehicle is inputted to an image processing part 18 included in a navigation device, and converted into a digital image signal by an A/D converter 21 to be frame image data having a prescribed frame cycle. Two pieces of continuous frame image data are respectively stored in 1st and 2nd image memories 22 and 23. A motion vector detecting part 24 detects a motion vector in each area of the image on the basis of these frame image data and vehicle speed data, and a motion vector processing part 25 calculates a distance to a road edge from the vehicle on the basis of the motion vector. Further, the width of a road where the vehicle travels can be calculated from the distance. Thus, an alarm is issued to a driver when the vehicle approaches the road edge, a traffic lane on which the vehicle travels is decided to guide the driver to a right lane, the width of the road is stored to be effectively utilized later so that the safety and convenience of the vehicle can be improved.



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CLAIMS

[Claim(s)]
[Claim 1] The image processing system characterized by to have an image pick-up means to picturize the side of a mobile and to output a picture signal, a movement vector detection means to detect a movement vector for every field of the picturized image based on said picture signal which a mobile is moving, and a distance calculation means distinguish said detected spatial rate of change of the magnitude of a movement vector, and compute the distance to a road edge based on this rate of change.
[Claim 2] Said distance calculation means is an image processing system according to claim 1 characterized by computing the 1st distance to a left-hand side road edge, and the 2nd distance to a right-hand side road edge including 1st image pick-up means by which said image pick-up means picturizes the left-hand side side of a mobile, and the 2nd image pick-up means which picturizes the right-hand side side of a mobile.
[Claim 3] The image processing system according to claim 2 characterized by having further a width-of-road calculation means to compute the width of road of the transit road of a mobile, based on said the 1st distance and said 2nd distance.
[Claim 4] It is an image processing system given in either of claim 1 to claims 3 which said picture signal is constituted considering frame image data with a predetermined frame period as a unit, and are characterized by said movement vector detection means detecting said movement vector based on two continuous frame image data.
[Claim 5] Said image pick-up means is an image processing system given in either of claim 1 to claims 4 characterized by being installed in a before [a mobile] side.
[Claim 6] Said image pick-up means is an image processing system given in either of claim 1 to claims 5 characterized by picturizing the side of the approach before slant of a mobile.
[Claim 7] Said image pick-up means is an image processing system given in either of claim 1 to claims 6 characterized by picturizing the side of the bottom approach of slant of a mobile.
[Claim 8] It is the image-processing approach of performing an image processing based on the picture signal outputted from an image pick-up means to picturize the side of a mobile. The movement vector detection process of detecting a movement vector for every field of the picturized image based on said picture signal which a mobile is moving, The image-processing approach characterized by having the distance calculation process which distinguishes the spatial rate of change of the magnitude of said detected movement vector, and computes the distance to a road

edge based on this rate of change.
[Claim 9] It is the image-processing approach according to claim 8 which said picture signal is outputted, respectively from the 1st image pick-up means which picturizes the left-hand side side of a mobile, and the 2nd image pick-up means which picturizes the right-hand side side of a mobile, and is characterized by said distance calculation process computing the 1st distance to a left-hand side road edge, and the 2nd distance to a right-hand side road edge.
[Claim 10] The image-processing approach according to claim 9 characterized by having further the width-of-road calculation process which computes the width of road of the transit road of a mobile based on said the 1st distance and said 2nd distance.
[Claim 11] It is the image-processing approach given in either of claim 8 to claims 10 which said picture signal is constituted considering frame image data with a predetermined frame period as a unit, and are characterized by said movement vector detection process detecting said movement vector based on two continuous frame image data.
[Claim 12] The sensor section which is navigation equipment which performs path guidance from the current position of a car to the destination based on map data, and contains the speed sensor which detects the passing speed of a car, An image pick-up means to picturize the side of a car and to output a picture signal, and a movement vector detection means to detect a movement vector for every field of the picturized image based on said picture signal under car transit, Navigation equipment characterized by having a distance calculation means to distinguish the spatial rate of change of the magnitude of said detected movement vector, and to compute the distance to a road edge based on this rate of change and said passing speed.
[Claim 13] Navigation equipment according to claim 12 characterized by having further a notice means to notify of the car having approached the road edge when said computed distance is smaller than the value set up beforehand.
[Claim 14] Navigation equipment according to claim 12 or 13 characterized by having further a width-of-road calculation means to compute the width of road of the transit road of a car, based on said computed distance.
[Claim 15] Navigation equipment according to claim 14 characterized by having further a width-of-road data storage means to relate the width-of-road data corresponding to said computed width of road with said map data, and to memorize them possible [updating].
[Claim 16] Navigation equipment according to claim 14 or 15 characterized by having further a slow lane judging means to judge the slow lane of a car based on the calculation result of said distance calculation means and said width-of-road calculation means, and a lane notice means to notify of the proper lane should collate said judged slow lane with the optimal path to said destination, and it should run based on this collating result.
[Claim 17] the case where, as for said lane notice means, said judged slow lane does not agree into said proper lane -- this -- the navigation equipment according to claim 16 characterized by notifying of a proper lane.
[Claim 18] the case where, as for said lane notice means, said judged slow lane agrees into said proper lane -- this -- the navigation equipment according to claim 16 characterized by notifying of agreeing into a proper lane.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention belongs to the technical field of the image processing system and the image-processing approach of asking for the distance and the width of road to a road edge based on the picture signal from an image pick-up means, and navigation equipment in the car under transit.
[0002]
[Description of the Prior Art] The navigation equipment which displays the current position which detected the current position of the car as a mobile and was detected with the surrounding road map from the former on a display screen, and performs path guidance is used widely. In this kind of navigation equipment, it has the mass record medium with which map data were memorized, and it is used in order to generate the indicative data on a display screen. In addition to data, various data for a display, etc. about a road configuration, the width-of-road information which accompanies this is included in the map data on a record medium. Therefore, the width-of-road information corresponding to the road under transit can be read, and the width of road of the road it is running now can be grasped.
[0003]
[Problem(s) to be Solved by the Invention] However, with the above-mentioned conventional navigation equipment, the width-of-road information included in map data does not show the exact width of road, and showed the width of road of the outline of the road like 5.5m-8m with it. Therefore, the fine exact width-of-road information corresponding to the point of a road was unacquirable. Furthermore, it not only gets to know the width of road of a road, but it asks real time for the distance to a road, and the needs for using this for insurance transit of a car are strong.
[0004] Then, by making this invention in view of such a problem, and detecting the structures other than the path road surface which adjoins a wall surface, and a slot or a path road surface out of an image based on the image picturized from the car under transit It aims at offering the navigation equipment which can perform warning and guidance for securing insurance transit to a driver according to the result of the image processing system for mount which can ask for the distance and the width of road to a road edge, and an image processing.
[0005]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, an image processing system according to claim 1 An image pick-up means

to picturize the side of a mobile and to output a picture signal, and a movement vector detection means to detect a movement vector for every field of the picturized image based on said picture signal which a mobile is moving, The spatial rate of change of the magnitude of said detected movement vector is distinguished, and it is characterized by having a distance calculation means to compute the distance to a road edge based on this rate of change.

[0006] According to this invention, with an image processing system, in mobiles, such as a car under transit, the image pick-up by the image pick-up means is performed towards the side, and a picture signal is outputted. This picture signal is compared at the two times, and the movement vector for every field is detected. Although the rate of change of a movement vector serves as abbreviation regularity in parts for a horizontal level, such as a path road surface in an image, the break point of rate of change arises at a road edge. Therefore, it can distinguish for every fields of these, a road edge can be distinguished, and the distance to a road edge can be further computed based on the magnitude of a movement vector. Therefore, the computed distance is available for applications, such as security under transit, and exchange of navigation, and can raise the safety and convenience of a car.

[0007] Said distance calculation means is characterized by computing the 1st distance to a left-hand side road edge, and the 2nd distance to a right-hand side road edge including 1st image pick-up means by which, as for said image pick-up means, an image processing system according to claim 2 picturizes the left-hand side side of a mobile in an image processing system according to claim 1, and the 2nd image pick-up means which picturizes the right-hand side side of a mobile.

[0008] Towards left-hand side, towards right-hand side, the 2nd image pick-up means picturizes, respectively, and, according to this invention, the 1st image pick-up means outputs a picture signal by mobiles, such as a car under transit. Like invention according to claim 1, subsequent processing is performed about a right-hand side image and a left-hand side image, and can compute the distance to the both-sides road edge of a mobile. Therefore, two computed distance is acquired, and grasp of the car location in a transit road becomes easy, and can raise the safety and convenience of a car further.

[0009] An image processing system according to claim 3 is characterized by having further a width-of-road calculation means to compute the width of road of the transit road of a mobile, based on said the 1st distance and said 2nd distance in an image processing system according to claim 2.

[0010] According to this invention, based on two distance computed corresponding to the image of the right and left in mobiles, such as a car, the width of road of a transit road is computable. For example, when the image pick-up means is installed in the flank of car both sides, if two distance is applied and the distance between image pick-up means is applied further, the width of road will be obtained. Therefore, using this width of road, the insurance under transit is secured or it becomes useful to the improvement in functional of the security and navigation of a car, such as acquiring width-of-road data.

[0011] Said picture signal is constituted considering the frame image data in which an image processing system according to claim 4 has a predetermined frame period in an image processing system given in either of claim 1 to claims 3 as a unit, and said movement vector detection means is characterized by detecting said movement vector

based on two continuous frame image data.
[0012] According to this invention, the object of an image processing is frame image data outputted for every frame period, and an above-mentioned image processing is performed using two continuous frame image data. Therefore, an image processing is always carried out to real time during transit of a car, and the image processing system which can respond to the situation of a car promptly can be realized.
[0013] An image processing system according to claim 5 is characterized by being installed in a before [a mobile] side by said image pick-up means in an image processing system given in either of claim 1 to claims 4.
[0014] displaying the picture signal from the image pick-up means installed in the before [a mobile] side on the display screen according to this invention -- the above-mentioned operation -- in addition, a check by looking usually checks easily the longitudinal direction by the side of before [difficult] a mobile by looking -- things can be carried out and it becomes much more useful at the security of a car.
[0015] An image processing system according to claim 6 is characterized by said image pick-up means picturizing the side of the approach before slant of a mobile in an image processing system given in either of claim 1 to claims 5.
[0016] Since it was made to perform above-mentioned processing based on the picture signal from an image pick-up means to picturize the approach before slant of a mobile according to this invention, the distance to the road edge in the travelling direction front of a car can be computed by preceding it in time, and the run state of a car can be grasped quickly.
[0017] An image processing system according to claim 7 is characterized by said image pick-up means picturizing the side of the bottom approach of slant of a mobile in an image processing system given in either of claim 1 to claims 6.
[0018] Since it was made to perform above-mentioned processing based on the picture signal from an image pick-up means to picturize the bottom approach of slant of a mobile according to this invention, even if it is the case where a road edge is approached, into a field angle, it becomes easy to catch a road edge and the safety of a transit car can be raised further.
[0019] The image-processing approach according to claim 8 is the image-processing approach of performing an image processing based on the picture signal outputted from an image pick-up means to picturize the side of a mobile. The movement vector detection process of detecting a movement vector for every field of the picturized image based on said picture signal which a mobile is moving, The spatial rate of change of the magnitude of said detected movement vector is distinguished, and it is characterized by having the distance calculation process which computes the distance to a road edge based on this rate of change.
[0020] According to this invention, the picture signal from the image pick-up means installed in mobiles, such as a car under transit, is inputted, according to the same operation as invention according to claim 1, a road edge can be distinguished and the distance to a road edge can be further computed based on the magnitude of a movement vector. Therefore, the computed distance is available for applications, such as security under transit, and exchange of navigation, and can raise the safety and convenience of a car.
[0021] The image-processing approach according to claim 9 is outputted for said picture signal in the image-processing approach according to claim 8, respectively

from the 1st image pick-up means which picturizes the left-hand side side of a mobile, and the 2nd image pick-up means which picturizes the right-hand side side of a mobile, and said distance calculation process is characterized by computing the 1st distance to a left-hand side road edge, and the 2nd distance to a right-hand side road edge.
[0022] According to this invention, the picture signal corresponding to the left-hand side side from the 1st image pick-up means installed in mobiles, such as a car under transit, and the picture signal corresponding to the right-hand side side from the 2nd image pick-up means are inputted, respectively, and the distance to the both-sides road edge of a mobile can be computed according to the same operation as invention according to claim 2. Therefore, two computed distance is acquired, and grasp of the car location in a transit road becomes easy, and can raise the safety and convenience of a car further.
[0023] The image-processing approach according to claim 10 is characterized by having further the width-of-road calculation process which computes the width of road of the transit road of a mobile based on said the 1st distance and said 2nd distance in the image-processing approach according to claim 9.
[0024] According to this invention, it becomes useful to the improvement in functional of the security and navigation of a car, such as the width of road of a transit road being computable, and securing the insurance under transit or acquiring width-of-road data using this width of road, according to the same operation as invention according to claim 3.
[0025] Said picture signal is constituted considering the frame image data in which the image-processing approach according to claim 11 has a predetermined frame period in the image-processing approach given in either of claim 8 to claims 10 as a unit, and said movement vector detection process is characterized by detecting said movement vector based on two continuous frame image data.
[0026] Since an above-mentioned image processing is performed by the same operation as invention according to claim 4 using two continuous frame image data according to this invention, an image processing is always carried out to real time during transit of a car, and the image-processing approach which can respond to the situation of a car promptly can be offered.
[0027] The sensor section which navigation equipment according to claim 12 is navigation equipment which performs path guidance from the current position of a car to the destination based on map data, and contains the speed sensor which detects the passing speed of a car, An image pick-up means to picturize the side of a car and to output a picture signal, and a movement vector detection means to detect a movement vector for every field of the picturized image based on said picture signal under car transit, The spatial rate of change of the magnitude of said detected movement vector is distinguished, and it is characterized by having a distance calculation means to compute the distance to a road edge based on this rate of change and said passing speed.
[0028] According to this invention, while the passing speed of a car is detected by the sensor section of navigation equipment, the image pick-up by the image pick-up means is performed towards the car side, and a picture signal is outputted. And the image processing by the same operation as invention according to claim 1 is performed. Therefore, it can utilize effective in reservation of safety, or other various

functions, and the computed distance can raise the safety and convenience of a car.
[0029] In navigation equipment according to claim 12, navigation equipment according to claim 13 is characterized by having further a notice means to notify of the car having approached the road edge, when said computed distance is smaller than the value set up beforehand.
[0030] According to this invention, with navigation equipment, since it judges that the car approached the road edge too much based on the distance to a road edge and the driver was notified of that, the safety and convenience of a car can be raised further.
[0031] Navigation equipment according to claim 14 is characterized by having further a width-of-road calculation means to compute the width of road of the transit road of a car in navigation equipment according to claim 12 or 13.
[0032] When according to this invention the width of road of a transit road can be computed, for example, the image pick-up means is installed in the flank of car both sides by the car it runs, if two distance is applied and the width of face of a car is applied further, the width of road will be obtained. Therefore, it becomes useful to the improvement in functional of the security and navigation of a car to secure the insurance under transit, or to acquire width-of-road data, to relate with map data and to hold using this width of road, etc.
[0033] Navigation equipment according to claim 15 is characterized by having further a width-of-road data storage means to relate the width-of-road data corresponding to said computed width of road with said map data, and to memorize them possible [updating] in navigation equipment according to claim 14.
[0034] According to this invention, with the navigation equipment for mount, it memorizes possible [updating of the width-of-road data corresponding to the width of road for which the width-of-road data storage means was asked as mentioned above]. Therefore, since it can utilize when the width-of-road data of the road the car ran are held and it passes along the road same after that again, the function of navigation equipment is supportable.
[0035] Navigation equipment according to claim 16 is characterized by having further a slow lane judging means to judge the slow lane of a car based on the calculation result of said distance calculation means and said width-of-road calculation means, and a lane notice means to notify of the proper lane should collate said judged slow lane with the optimal path to said destination, and it should run based on this collating result in navigation equipment according to claim 14 or 15.
[0036] According to this invention, with navigation equipment, while a car runs the road of two or more lanes, the slow lane is judged based on the distance and the width of road to a road edge. And the judged lane is collated with an optimal path and notifies a driver of the proper lane it should run based on the result. Therefore, since it is made to run the lane corresponding to an optimal path, attention of a driver can be called, and a comfortable navigation function can be realized.
[0037] the case where, as for said lane notice means, said judged slow lane does not agree into said proper lane in navigation equipment according to claim 16 in navigation equipment according to claim 17 -- this -- it is characterized by notifying of a proper lane.
[0038] According to this invention, the judged lane is collated with an optimal path by the same operation as invention according to claim 16, and when it is judged that it is not running the lane where a car is proper, a driver is notified of a proper lane.

Therefore, avoiding the unnecessary notice at the time of running the proper lane, a necessary minimum notice is performed and a comfortable navigation function can be realized.

[0039] the case where, as for said lane notice means, said judged slow lane agrees into said proper lane in navigation equipment according to claim 16 in navigation equipment according to claim 18 -- this -- it is characterized by notifying of agreeing into a proper lane.

[0040] According to this invention, the judged lane is collated with an optimal path by the same operation as invention according to claim 16, and when [at which it is running the lane where a car is proper] judged, a driver is notified of that. Therefore, a driver is made to know running the proper lane and the comfortable navigation function to give sense of security to a driver can be realized.

[0041]

[Embodiment of the Invention] Hereafter, the gestalt of suitable operation of this invention is explained based on a drawing. In the gestalt of the following operations, the case where it applies to the navigation equipment in which this invention is carried by the car is explained.

[0042] Drawing 1 is drawing showing the outline configuration of the navigation equipment concerning this operation gestalt. The navigation equipment shown in drawing 1 is constituted including a control section 11, the map data storage section 12, the width-of-road data storage section 13, the sensor section 14, the current position detecting element 15, a display 16, a loudspeaker 17, the image-processing section 18, and CCD cameras 19a and 19b.

[0043] In the above configuration, a control section 11 controls actuation of the whole navigation equipment. A control section 11 outputs and inputs data while it reads and performs the control program which consists of a CPU etc. and is stored in ROM which is not illustrated and sends out a control signal to each component of navigation equipment.

[0044] The map data storage section 12 is memory with the big storage capacity which stores map data, for example, CD-ROM and DVD-ROM are used. The map data stored in the map data storage section 12 are constituted including road configuration data, name data, background data, etc.

[0045] The width-of-road data storage section 13 is memory recorded possible [updating of the width-of-road data under car transit obtained in connection with the image processing concerning this invention]. Although simple width-of-road information is included also in the map data of the above-mentioned map data storage section 12, the width-of-road data memorized by the width-of-road data storage section 13 are still more detailed data, and are data which asked for the width of road which changes according to the location of a road correctly. In addition, about the generation method of width-of-road data, it mentions later.

[0046] The sensor section 14 contains various sensors required in order to detect the current position of a car. Specifically, it is constituted including the speed sensor which detects the rate of a car, the bearing sensor which detects the bearing variation of a car, the GPS receive section which receives the electric wave from a GPS (Global Positioning System) satellite.

[0047] Based on the output signal from the sensor section 14, the current position detecting element 15 computes the current position of a car, and outputs current

position data. In addition, current position data are collated with the above-mentioned map data by the control section 11, and are amended by map matching processing etc.
[0048] Under directions of a control section 11, while map data are displayed in various modes, it superimposes on this and the current position of a car is displayed on a display 16 as a car mark. This display 16 consists of CRT, a liquid crystal display component, etc. Moreover, from a loudspeaker 17, while the induction information in alignment with the path of a car is outputted by voice, the below-mentioned guidance voice is outputted in relation to the image processing concerning this invention.
[0049] The image-processing section 18 is a means to perform the image processing which analyzes the picture signal from two sets of CCD cameras 19a and 19b installed in a car, and starts this operation gestalt. Here, the configuration and actuation of the image-processing section 18 are explained using drawing 2 .
[0050] As shown in drawing 2 , the image-processing section 18 is constituted including A/D converter 21, the 1st image memory 22, the 2nd image memory 23, the movement vector detecting element 24, and the movement vector processing section 25. Moreover, the image control section 18 operates according to the control signal from a control section 11. In addition, although the image-processing section 18 processes the picture signal from two sets of CCD cameras 19a and 19b like the after-mentioned in fact, since it is easy, it explains the case where the picture signal from one CCD camera19a is processed.
[0051] In drawing 2 , A/D converter 21 changes into a digital image signal the analog picture signal based on the image picturized by CCD camera 19a. Usually, the digital image signal outputted from A/D converter 21 constitutes one frame image data for every predetermined frame period, and consists of two or more continuous frame image data.
[0052] The 1st image memory 22 and the 2nd image memory 23 store the frame image data outputted from A/D converter 21, respectively. The 1st image memory 22 stores the newest frame image data, and the 2nd image memory 23 stores the frame image data in front of one. Therefore, in the image-processing section 18, the newest image data for two frames is always held, and the below-mentioned processing is performed using these.
[0053] The movement vector detecting element 24 detects the movement vector for every field in an image based on the frame image data stored in the 1st image memory 22 and the 2nd image memory 23. Under the present circumstances, the vehicle speed data outputted from the sensor section 14 are used.
[0054] Moreover, based on the movement vector detected by the movement vector detecting element 24, the movement vector processing section 25 asks for the distance to the road edge in a transit road, and the width of road based on this, and outputs them as width-of-road data etc.
[0055] In addition, about the detail of the processing in the movement vector detecting element 24 and the movement vector processing section 25, it mentions later.
[0056] Returning to drawing 1 , CCD cameras 19a and 19b are installed near the both ends ahead of a car, respectively, picturize the right-and-left side of a car, and output a picture signal. The installation condition to the car of CCD cameras 19a and 19b is shown in drawing 3 here.
[0057] Drawing 3 (a) is drawing showing the installation condition of CCD cameras 19a and 19b seen from the car upper part. As shown in drawing 3 (a), CCD cameras

19a and 19b are attached in the car-body upper part of right-and-left both sides at the car front side. CCD camera 19a is attached in car left-hand side, and CCD camera 19b is attached in car right-hand side, respectively. CCD camera 19a turns to the side on the left-hand side of a car, and is attached possible [an image pick-up], and CCD camera 19b turns to the side on the right-hand side of a car, is attached possible [an image pick-up], and is installed by respectively symmetrical arrangement.

[0058] Moreover, drawing 3 (b) is drawing showing the installation condition seen from the car front with the image pick-up range about CCD camera 19a. In addition, since it is easy, only the image pick-up condition in the case of on the left-hand side of a car is shown. As shown in drawing 3 (b), CCD camera 19a picturizes the range of the field angle theta toward a wall surface. Usually, it is attached in the include angle at which a path road surface is reflected in the lower part while a upside wall surface is reflected in the picturized image. In this invention, the distance DL to a left-hand side road edge is computed based on the image picturized by CCD camera 19a.

[0059] In addition, CCD camera 19a is attached in a location with a height [of a car] of about 1m. Moreover, in right-hand side CCD camera 19b, it will be in drawing 3 (b) and a symmetrical image pick-up condition, and it will compute the distance DR to a right-hand side road edge.

[0060] Next, the principle of the image processing concerning this operation gestalt is explained with reference to drawing 4 - drawing 8 .

[0061] Drawing 4 is drawing which expressed the image picturized by above-mentioned CCD cameras 19a and 19b with the model of a pinhole camera. In drawing 4 , the image plane P0 corresponding to the photo detector section of CCD camera 19a and the focal plane F corresponding to the lens section separate a focal distance f, and are arranged in parallel. The lens core C of a focal plane F corresponds to a pinhole, and considers a space-coordinates system (X, Y, Z) centering on this lens core C. On the other hand, by the image plane P0, camera system of coordinates (x y) are considered by setting space coordinates (0, 0, -f) as the image core c.

[0062] Here, the point M of a space-coordinates system (Xm, Ym, Zm) is considered. This point M can be made to correspond to the position on the wall surface in drawing 3 (b). Considering the central projection over this point M, even an image plane P0 is connected in a straight line through the lens core C of a focal plane F from Point M, and it is projected on the point m of camera system of coordinates (xm, ym). At this time, the relation between Point M (Xm, Ym, Zm) and the projected point m (xm, ym) is expressed with a degree type.

[0063]

[Equation 1] xm = f-Xm/Zmym = It is drawing where drawing 5 expressed the relation between a space-coordinates system (X, Y, Z) and the pixel system of coordinates (u, v) of image data to the f-Ym/Zm order corresponding to drawing 4 . Since it is easy, while arranging the image plane P0 of drawing 4 to the front side of a focal plane F in drawing 5 , it considers as a pixel image system (u, v) by reversing the x axis of camera system of coordinates (x y), and the y-axis, respectively, and considering as u shaft and v shaft. Even if it transposes arrangement of drawing 4 to arrangement of drawing 5 , since it is mutually equivalent, the same relation is realized.

[0064] In drawing 5 , the image plane P1 of a pixel image system supports the display image of the horizontal number Nw of pixels, and the vertical number Nh of pixels,

and the pixel of NwxNh is contained in an image plane P1 in all. On the other hand, this image plane P1 is in agreement with the light-receiving field of CCD cameras 19a and 19b with which size is set to Breadth w and height h. And if the point M of a space-coordinates system (X, Y, Z) is considered like drawing 4 , as shown in drawing 5 , it will be connected in a straight line to the lens core C of a focal plane F through the point m of an image plane P1 (u, v).

[0065] Here, considering the central projection over Point m, corresponding to several 1, the relation between Point M (X, Y, Z) and the projected point m (u, v) is expressed with a degree type like drawing 4 .

[0066]

[Equation 2] u = (f-X/Z) -Nw/wv = (f-Y/Z) -Nh/h, several 2 [i.e.,], expresses the pixel location in the image plane P1 of Point m (u, v). In several 2, u corresponds to a horizontal pixel location and v supports the vertical pixel location.

[0067] With this operation gestalt, since the image picturized from the car under transit is processed, it is necessary to assume a motion of the body in an image plane P1. Therefore, it is necessary to ask for the optical flow in an image plane P1, i.e., movement vector V, (u, v). When brightness I of the same point of three-dimension space is kept constant, the following differential equation between space-time is realized.

[0068]

[Equation 3]

dI/dt = Ix-u+Iy-v+It = It corrects zero and a partial differential with horizontal Ix and Iy are [a vertical partial differential and It of the partial differential of time amount shaft orientations, and u and v] the components of horizontal [of above-mentioned movement vector V], and a perpendicular direction in an image plane P1, respectively.

[0069] Next, how to ask for movement vector V using drawing 6 and drawing 7 is explained. As shown in drawing 6 , reference block R is defined in the image plane P1 in time of day t. With the upper left pixel pr as the starting point, this reference block R is the rectangle field of the range of n pixels, and contains the pixel of a mxn individual in u shaft in all at m pixels and v shaft. And an image plane P1 is divided into two or more reference block R, and each reference block R of every is asked for movement vector V. The example of drawing 6 shows reference block R used as m= 8 and n= 8.

[0070] Drawing 7 is drawing explaining how to ask for movement vector V to predetermined reference block R in an image plane P1. Drawing 7 corresponds to the image plane P1 in time-of-day t+delta t in which deltat has passed since the time of day t of drawing 6 . And based on the vehicle speed data from the sensor section 14 etc., the predetermined field in an image plane P1 is beforehand appointed as search range S. The search range S is a rectangle field where it becomes M pixels on u shaft, and it becomes v shaft with N pixel, and M and N usually become sufficiently large compared with m and n.

[0071] And comparison Brock C of reference block R and the same size is defined as a position to the search range S. Since size is sufficiently large compared with reference block R, it is necessary, as for the search range S, to move comparison Brock's C location little by little in the search range S. By drawing 7 , comparison Brock C is the size of mxn like reference block R, and shows the pixel pc at the upper

left of comparison Brock C corresponding to the pixel pr at the upper left of a reference block. The pixel at the upper left of the search range S is set as comparison Brock's C pixel pc at first, after that, in the search range S, it moves 1 pixel of locations of Pixel pc at a time to u shaft orientations or v shaft orientations, and the below-mentioned operation is performed about all comparison Brock C that can give a definition in the search range S.
[0072] Subsequently, a correlation value is calculated among comparison Brock C in reference block R in the time of day t of drawing 6 , and time-of-day t+delta t of drawing 7 . Here, in the image data which is the set of a pixel, since the concentration value is made to correspond to all the pixels of a mxn individual, it asks for the difference of the concentration value for every pixel to which reference block R and comparison Brock C correspond. A correlation value is calculable if the sum about the pixel of a mxn individual is taken to the difference for every pixel of this concentration value.
[0073] And to reference block R, the correlation value between all comparison Brock C in the search range S is calculated, and it looks for comparison Brock C who gives the minimum correlation value. For example, suppose that comparison Brock C who shows drawing 7 gives the minimum correlation value.
[0074] In this case, as shown in drawing 7 , in an image plane P1, the vector which turns on comparison Brock C in time-of-day t+delta t from reference block R in the time of day t shown by the dotted line can be determined as movement vector V.
[0075] Although drawing 7 showed only one movement vector V, it asks for movement vector V in fact about all reference block R which can be defined as an image plane P1. This searches for spatial distribution of movement vector V. And the below-mentioned processing is performed based on spatial distribution of this movement vector V.
[0076] Next, the above-mentioned distance DR and DL and the calculation approach of the width of road are explained using drawing 8 . Drawing 8 is drawing showing an example of distribution of movement vector V in the image picturized from CCD camera19a. In drawing 8 , since it is easy, in the longitudinal direction of a car, the case where the path road surface and the wall surface have touched in the boundary section 30 is assumed like drawing 3 (b). Moreover, distribution of movement vector V on Rhine L1 in time of day t is considered.
[0077] As shown in drawing 8 , in the image picturized in CCD camera 19a, the magnitude of movement vector V is changing with the rate of change of abbreviation regularity by the path road surface in the lower part of the boundary section 30 to the magnitude of movement vector V serving as constant value on the wall surface in the upper part of the boundary section 30. Thus, the magnitude of movement vector V serves as a value depending on the distance z to a photography object.
[0078] That is, supposing it performs the image pick-up by CCD camera 19a by frame period T in the car it is running at a rate v0 (m/second), the migration length d of a 1 inter-frame car is [0079].
[Equation 4] d = v0andT (m)
It can express. Here, if a photography object considers the situation which does not change only in the direction of u in a motion, the direction of v, and the direction of z relatively [car], the following formulas will be realized that what is necessary is several 2 just to substitute above-mentioned x=d.

[0080]
[Equation 5] u = (f-d/z) -Nw/w = (f-v0.T/z) It can express -Nw/w. Movement vector V (u, 0) becomes settled by u shown in several 5, and this u is in agreement with the magnitude of movement vector V. Thus, the magnitude of movement vector V is in inverse proportion to the distance z with a photography object.
[0081] Drawing 9 is drawing in which the magnitude of movement vector V of Rhine L1 shows signs that it changes corresponding to several 5. In drawing 9 , while a continuous line shows the magnitude of the movement vector of a photography object to v shaft in the image of drawing 8 , the dotted line shows distance z. Since distance z becomes fixed, on a wall surface, it becomes fixed [the magnitude of movement vector V], so that drawing 8 may show. On the other hand, since it becomes small at a rate of abbreviation regularity so that distance z goes by the path road surface caudad, several 5 u becomes large linearly.
[0082] Therefore, in drawing 9 , movement vector V cannot change with the rate of change of abbreviation regularity, but can distinguish a wall surface and a path road surface based on whether it becomes in general fixed, and can also judge the location of the boundary section 30. And MV (pixel), then the distance DL to the above-mentioned wall surface are based on several 5 in the average of movement vector V of a wall surface, and it is [0083].
[Equation 6]
DL = (f-v0.T/MV) -Nw/w can be computed and calculated.
[0084] In addition, although movement vector V becomes small with the rate of change of abbreviation regularity as it goes above an image by the path road surface when a slot exists in a road edge, on the boundary of a path road surface and a slot, it changes uniformly [rate of change] and rapidly partially. Therefore, a slot can be detected by distinguishing this break point, and the distance DL to a road edge can be found based on the magnitude of movement vector V before and behind that.
[0085] Moreover, what is necessary is to generate two or more fields where movement vector V becomes in general fixed, when becoming a partial wall surface like the guard rail instead of a single wall surface, but just to use the distance DL which finds the distance DL about two or more fields, among those serves as the shortest, while detecting a break point as mentioned above. Also when a guard rail adjoins a road edge, the distance DL of a road edge can be found based on the distance to the field corresponding to a guard rail.
[0086] In addition, as an example of each numeric value in several 5, it becomes focal distance f= 4 (mm), horizontal pixel number Nw=320 (pixel), and breadth [of a light-receiving field] w=4(mm) frame period T=1 / 30 (second) extent. .
[0087] If the above image processing is similarly performed to the image by two CCD cameras 19a and 19b, the distance DL and DR to the road edge in right and left of a car will be found. Therefore, while adding these, in consideration of the breadth of a car, the width of road in the road under transit is further computable. For example, when a car has Breadth W in the installation condition of drawing 2 (b), the width of road RW is [0088].
[Equation 7] RW ** It can ask in approximation with DL+DR+W.
[0089] In addition, if the width-of-road data corresponding to the computed width of road RW are related with map data and memorized possible [updating] in the width-of-road data storage section 13, it can use for various kinds of below-mentioned

processings.

[0090] Next, the concrete image processing in the navigation equipment concerning this operation gestalt is explained with reference to drawing 10 and drawing 11 . Drawing 10 is a flow chart which shows processing for the car under transit to prevent approaching a road edge, and drawing 11 is a flow chart which shows processing for the car under transit the road of two or more lanes to make it run a proper lane to a setting path. In addition, drawing 10 and drawing 11 are processings mainly performed according to control of a control section 11.

[0091] If the processing shown in drawing 10 is started, the distance DL and DR to the road edge of both sides will be found, and the width of road RW will be computed by processing of the above image-processing sections 18 according to several 7 based on this (step S1). And the width-of-road data corresponding to the width of road RW computed at step S1 are related with map data, and are written in the width-of-road data storage section 13 (step S2). At this time, it may be made to write in width-of-road data in the predetermined point path on the street set up beforehand.

[0092] Subsequently, based on the distance DL and DR acquired in step S1, it is judged whether the car under transit visits a road edge too much (step S3). namely, what is necessary is to set up a predetermined distance used as criteria, and just to judge that a car visits a road edge too much and comes out to it, when distance DL or DR serves as a small value from this predetermined distance

[0093] When the decision result of step S3 is "YES", a car visits a road edge too much, and comes out to it, and it warns a driver of a certain thing (step S4). For example, what is necessary is just to output as voice the predetermined message which visits a road edge too much, comes out to it, and shows a certain purport from a loudspeaker 17. Or the same message or a display notation may be displayed on a display 16.

[0094] After finishing step S4 when the decision result of step S3 is "NO" or, it judges whether a car is running or not (step S5). When a car is not running (step S5; NO), since it is not necessary to perform an image processing, processing is finished. On the other hand, when a car is still running (step S5; YES), processing of step S1 - step S5 is repeated.

[0095] In navigation equipment, real time can be asked for the always exact width of road RW by processing the above step S1 - step S5. And since it was made to warn a driver when the distance DL and DR to a road edge was supervised and the car under transit visited a road edge too much, operation of a driver can be assisted and the insurance under transit can be secured. Moreover, since width-of-road data were suitably written in the width-of-road data storage section 13, when running the behind same road, it becomes possible to utilize width-of-road data effectively.

[0096] Next, the desired destination is set as navigation equipment and processing shown in drawing 11 is performed under the situation that a path is judged. First, like step S1, the distance DL and DR to the road edge of both sides is found, and the width of road RW is computed further (step S11).

[0097] And the lane information over the lane under transit included in the map data of the map data storage section 12 is read (step S12). Since the road under transit is the information which shows **** with what lane, this lane information judges whether the roads under transit are two or more lanes based on lane information (step S13).

[0098] When the decision result of step S13 is "YES", based on the decision result of step S11, it judges which lane is under transit among two or more lanes now (step S14). This judgment can be performed based on a ratio with the distance DL and DR to the road edge of the both sides of the car for which it asked at step S1.
[0099] Then, the lane judged at step S14 judges whether it is a proper lane corresponding to the path which arrives at the destination (step S15). That is, if the case where it is running the road of three lanes, for example is taken for an example, you may be which lane when a right-hand side lane becomes proper when turning to the right ahead generally, a left-hand side lane serves as fitness when turning left ahead, and going straight on as it is. Or the information on the proper lane at the time of left turn and right-turn may be set up beforehand.
[0100] As a result of the judgment of step S15, when the car is running the proper lane, processing (step S15; YES) is finished. On the other hand, when the car is running the lane which is not proper, guidance of lane modification is directed to (step S15; NO) and a driver (step S16). for example, the case where it is running the left-hand side lane before the right-turn point -- already -- what is necessary is to output as voice the message of a purport which urges moving to 2 lane right to a driver from a loudspeaker 17, or just to display it on a display 16
[0101] In navigation equipment, the lane in which a car is located by the road of two or more lanes can be judged on real time by processing the above step S11 - step S16. And unnecessary guidance does not need to be performed, when guidance is performed only when required and it has already run the proper lane, since it was made to guide lane modification to a driver only when it was not located in a proper lane, in order to perform right-turn, left turn, etc. Therefore, convenience is high and much more comfortable navigation becomes realizable for a driver.
[0102] In addition, in the example of drawing 11 , only while the car is running the lane which is not proper, when directing guidance of lane modification, namely, while running the proper lane, the case where guidance of lane modification was not directed was explained, but it is not restricted to this, but while [when a car is proper] running, it may be made to perform a certain guidance. For example, while running a proper lane, guidance of "please maintain the lane of this as" may be outputted with voice etc. Thereby, the driver under operation can be made to be able to grasp running the proper lane, and sense of security can be given to it.
[0103] As mentioned above, although this invention was explained based on the operation gestalt, this invention is not limited to the above-mentioned operation gestalt at all, and it can guess it easily for amelioration deformation various by within the limits which does not deviate from the meaning of this invention to be possible.
[0104] For example, you may make it display the image picturized with CCD cameras 19a and 19b as an image pick-up means on a display 16. With this operation gestalt, since it is installed so that CCD cameras 19a and 19b may picturize the just beside direction in the car front, before a driver arrives at the location which can see the side directly, on a display 16, a side image is checked by looking and the thing of it can be carried out. Especially when a car advances into a crossing from a narrow alley, a side image can be checked by looking only by taking out a car tip to a crossing slightly, and it becomes useful at insurance transit of a car.
[0105] Moreover, although the above-mentioned operation gestalt explained the case where it was installed so that CCD cameras 19a and 19b as an image pick-up means

may picturize the just beside direction in the side of a car, it is not restricted to this, but you may install so that the direction of before [slant] approach in the side of a car may be picturized. Thereby, a side image can be preceded in time, and can be processed and the distance to a road edge can be found timely.
[0106] Or you may install so that the direction [in / for CCD cameras 19a and 19b / the side of a car] of the bottom approach of slant may be picturized. Generally, if CCD cameras 19a and 19b with a vertical narrow field angle are used, when a car approaches a road edge, the case where a road edge stops entering in an image will arise. in such a case, since it comes out, and a road edge will enter in an image if the image pick-up direction of CCD cameras 19a and 19b comes together the bottom and there comes out and is even if it is, it becomes possible to find the distance to a road edge.
[0107] Moreover, CCD cameras 19a and 19b which have a larger field angle may be used. For example, when a horizontal field angle performs above-mentioned processing separately to the left-hand side field and the right-hand side field in each image pick-up image using some CCD cameras 19a and 19b about 180 degrees, the distance to a road edge may be found. The distance to a road edge can be found thereby still more finely.
[0108]
[Effect of the Invention] Since according to this invention the side of the car under transit is picturized with an image pick-up means, an image processing is performed and the distance to a road edge was found as explained above, the security of a transit car, acquisition of width-of-road data, etc. become possible [raising the safety and convenience of a car].
[0109] Moreover, if this invention is applied to navigation equipment, it will become possible to support navigation equipment and to aim at improvement in functional by the notice to the driver at the time of road edge contiguity of a car, the notice of lane modification based on a lane judging, a width-of-road data storage, etc.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention belongs to the technical field of the image processing system and the image-processing approach of asking for the distance and the width of road to a road edge based on the picture signal from an image pick-up means, and navigation equipment in the car under transit.

[Translation done.]

* NOTICES *

PRIOR ART

[Description of the Prior Art] The navigation equipment which displays the current position which detected the current position of the car as a mobile and was detected with the surrounding road map from the former on a display screen, and performs path guidance is used widely. In this kind of navigation equipment, it has the mass record medium with which map data were memorized, and it is used in order to generate the indicative data on a display screen. In addition to data, various data for a display, etc. about a road configuration, the width-of-road information which accompanies this is included in the map data on a record medium. Therefore, the width-of-road information corresponding to the road under transit can be read, and the width of road of the road it is running now can be grasped.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] Since according to this invention the side of the car under transit is picturized with an image pick-up means, an image processing is performed and the distance to a road edge was found as explained above, the security of a transit car, acquisition of width-of-road data, etc. become possible [raising the safety and convenience of a car].
[0109] Moreover, if this invention is applied to navigation equipment, it will become possible to support navigation equipment and to aim at improvement in functional by the notice to the driver at the time of road edge contiguity of a car, the notice of lane modification based on a lane judging, a width-of-road data storage, etc.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, with the above-mentioned conventional navigation equipment, the width-of-road information included in map data does not show the exact width of road, and showed the width of road of the outline of the road like 5.5m-8m with it. Therefore, the fine exact width-of-road information corresponding to the point of a road was unacquirable. Furthermore, it not only gets to know the width of road of a road, but it asks real time for the distance to a road, and the needs for using this for insurance transit of a car are strong.
[0004] Then, this invention is made in view of such a problem. The purpose is offering the navigation equipment which can perform warning and the guidance for securing insurance transit to a driver according to the result of the image processing system for mount which can ask for the distance and the width of road to a road edge , and an image processing by detecting the structures other than the path road surface which adjoins a wall surface , and a slot or a path road surface out of an image based on the image picturized from the car under transit .

[Translation done.]

MEANS

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, an image processing system according to claim 1 An image pick-up means to picturize the side of a mobile and to output a picture signal, and a movement vector detection means to detect a movement vector for every field of the picturized image based on said picture signal which a mobile is moving, The spatial rate of change of the magnitude of said detected movement vector is distinguished, and it is characterized by having a distance calculation means to compute the distance to a road edge based on this rate of change.
[0006] According to this invention, with an image processing system, in mobiles, such as a car under transit, the image pick-up by the image pick-up means is performed towards the side, and a picture signal is outputted. This picture signal is compared at the two times, and the movement vector for every field is detected. Although the rate of change of a movement vector serves as abbreviation regularity in parts for a horizontal level, such as a path road surface in an image, the break point of rate of change arises at a road edge. Therefore, it can distinguish for every fields of these, a road edge can be distinguished, and the distance to a road edge can be further computed based on the magnitude of a movement vector. Therefore, the computed distance is available for applications, such as security under transit, and exchange of navigation, and can raise the safety and convenience of a car.
[0007] Said distance calculation means is characterized by computing the 1st distance to a left-hand side road edge, and the 2nd distance to a right-hand side road edge including 1st image pick-up means by which, as for said image pick-up means, an image processing system according to claim 2 picturizes the left-hand side side of a mobile in an image processing system according to claim 1, and the 2nd image pick-up means which picturizes the right-hand side side of a mobile.
[0008] Towards left-hand side, towards right-hand side, the 2nd image pick-up means picturizes, respectively, and, according to this invention, the 1st image pick-up means outputs a picture signal by mobiles, such as a car under transit. Like invention according to claim 1, subsequent processing is performed about a right-hand side image and a left-hand side image, and can compute the distance to the both-sides road edge of a mobile. Therefore, two computed distance is acquired, and grasp of the car location in a transit road becomes easy, and can raise the safety and convenience of a car further.
[0009] An image processing system according to claim 3 is characterized by having further a width-of-road calculation means to compute the width of road of the transit

road of a mobile, based on said the 1st distance and said 2nd distance in an image processing system according to claim 2.

[0010] According to this invention, based on two distance computed corresponding to the image of the right and left in mobiles, such as a car, the width of road of a transit road is computable. For example, when the image pick-up means is installed in the flank of car both sides, if two distance is applied and the distance between image pick-up means is applied further, the width of road will be obtained. Therefore, using this width of road, the insurance under transit is secured or it becomes useful to the improvement in functional of the security and navigation of a car, such as acquiring width-of-road data.

[0011] Said picture signal is constituted considering the frame image data in which an image processing system according to claim 4 has a predetermined frame period in an image processing system given in either of claim 1 to claims 3 as a unit, and said movement vector detection means is characterized by detecting said movement vector based on two continuous frame image data.

[0012] According to this invention, the object of an image processing is frame image data outputted for every frame period, and an above-mentioned image processing is performed using two continuous frame image data. Therefore, an image processing is always carried out to real time during transit of a car, and the image processing system which can respond to the situation of a car promptly can be realized.

[0013] An image processing system according to claim 5 is characterized by being installed in a before [a mobile] side by said image pick-up means in an image processing system given in either of claim 1 to claims 4.

[0014] displaying the picture signal from the image pick-up means installed in the before [a mobile] side on the display screen according to this invention -- the above-mentioned operation -- in addition, a check by looking usually checks easily the longitudinal direction by the side of before [difficult] a mobile by looking -- things can be carried out and it becomes much more useful at the security of a car.

[0015] An image processing system according to claim 6 is characterized by said image pick-up means picturizing the side of the approach before slant of a mobile in an image processing system given in either of claim 1 to claims 5.

[0016] Since it was made to perform above-mentioned processing based on the picture signal from an image pick-up means to picturize the approach before slant of a mobile according to this invention, the distance to the road edge in the travelling direction front of a car can be computed by preceding it in time, and the run state of a car can be grasped quickly.

[0017] An image processing system according to claim 7 is characterized by said image pick-up means picturizing the side of the bottom approach of slant of a mobile in an image processing system given in either of claim 1 to claims 6.

[0018] Since it was made to perform above-mentioned processing based on the picture signal from an image pick-up means to picturize the bottom approach of slant of a mobile according to this invention, even if it is the case where a road edge is approached, into a field angle, it becomes easy to catch a road edge and the safety of a transit car can be raised further.

[0019] The image-processing approach according to claim 8 is the image-processing approach of performing an image processing based on the picture signal outputted from an image pick-up means to picturize the side of a mobile. The movement vector

detection process of detecting a movement vector for every field of the picturized image based on said picture signal which a mobile is moving, The spatial rate of change of the magnitude of said detected movement vector is distinguished, and it is characterized by having the distance calculation process which computes the distance to a road edge based on this rate of change.

[0020] According to this invention, the picture signal from the image pick-up means installed in mobiles, such as a car under transit, is inputted, according to the same operation as invention according to claim 1, a road edge can be distinguished and the distance to a road edge can be further computed based on the magnitude of a movement vector. Therefore, the computed distance is available for applications, such as security under transit, and exchange of navigation, and can raise the safety and convenience of a car.

[0021] The image-processing approach according to claim 9 is outputted for said picture signal in the image-processing approach according to claim 8, respectively from the 1st image pick-up means which picturizes the left-hand side side of a mobile, and the 2nd image pick-up means which picturizes the right-hand side side of a mobile, and said distance calculation process is characterized by computing the 1st distance to a left-hand side road edge, and the 2nd distance to a right-hand side road edge.

[0022] According to this invention, the picture signal corresponding to the left-hand side side from the 1st image pick-up means installed in mobiles, such as a car under transit, and the picture signal corresponding to the right-hand side side from the 2nd image pick-up means are inputted, respectively, and the distance to the both-sides road edge of a mobile can be computed according to the same operation as invention according to claim 2. Therefore, two computed distance is acquired, and grasp of the car location in a transit road becomes easy, and can raise the safety and convenience of a car further.

[0023] The image-processing approach according to claim 10 is characterized by having further the width-of-road calculation process which computes the width of road of the transit road of a mobile based on said the 1st distance and said 2nd distance in the image-processing approach according to claim 9.

[0024] According to this invention, it becomes useful to the improvement in functional of the security and navigation of a car, such as the width of road of a transit road being computable, and securing the insurance under transit or acquiring width-of-road data using this width of road, according to the same operation as invention according to claim 3.

[0025] Said picture signal is constituted considering the frame image data in which the image-processing approach according to claim 11 has a predetermined frame period in the image-processing approach given in either of claim 8 to claims 10 as a unit, and said movement vector detection process is characterized by detecting said movement vector based on two continuous frame image data.

[0026] Since an above-mentioned image processing is performed by the same operation as invention according to claim 4 using two continuous frame image data according to this invention, an image processing is always carried out to real time during transit of a car, and the image-processing approach which can respond to the situation of a car promptly can be offered.

[0027] The sensor section which navigation equipment according to claim 12 is

navigation equipment which performs path guidance from the current position of a car to the destination based on map data, and contains the speed sensor which detects the passing speed of a car, An image pick-up means to picturize the side of a car and to output a picture signal, and a movement vector detection means to detect a movement vector for every field of the picturized image based on said picture signal under car transit, The spatial rate of change of the magnitude of said detected movement vector is distinguished, and it is characterized by having a distance calculation means to compute the distance to a road edge based on this rate of change and said passing speed.
[0028] According to this invention, while the passing speed of a car is detected by the sensor section of navigation equipment, the image pick-up by the image pick-up means is performed towards the car side, and a picture signal is outputted. And the image processing by the same operation as invention according to claim 1 is performed. Therefore, it can utilize effective in reservation of safety, or other various functions, and the computed distance can raise the safety and convenience of a car.
[0029] In navigation equipment according to claim 12, navigation equipment according to claim 13 is characterized by having further a notice means to notify of the car having approached the road edge, when said computed distance is smaller than the value set up beforehand.
[0030] According to this invention, with navigation equipment, since it judges that the car approached the road edge too much based on the distance to a road edge and the driver was notified of that, the safety and convenience of a car can be raised further.
[0031] Navigation equipment according to claim 14 is characterized by having further a width-of-road calculation means to compute the width of road of the transit road of a car in navigation equipment according to claim 12 or 13.
[0032] When according to this invention the width of road of a transit road can be computed, for example, the image pick-up means is installed in the flank of car both sides by the car it runs, if two distance is applied and the width of face of a car is applied further, the width of road will be obtained. Therefore, it becomes useful to the improvement in functional of the security and navigation of a car to secure the insurance under transit, or to acquire width-of-road data, to relate with map data and to hold using this width of road, etc.
[0033] Navigation equipment according to claim 15 is characterized by having further a width-of-road data storage means to relate the width-of-road data corresponding to said computed width of road with said map data, and to memorize them possible [updating] in navigation equipment according to claim 14.
[0034] According to this invention, with the navigation equipment for mount, it memorizes possible [updating of the width-of-road data corresponding to the width of road for which the width-of-road data storage means was asked as mentioned above]. Therefore, since it can utilize when the width-of-road data of the road the car ran are held and it passes along the road same after that again, the function of navigation equipment is supportable.
[0035] Navigation equipment according to claim 16 is characterized by having further a slow lane judging means to judge the slow lane of a car based on the calculation result of said distance calculation means and said width-of-road calculation means, and a lane notice means to notify of the proper lane should collate said judged slow lane with the optimal path to said destination, and it should run based on this collating

result in navigation equipment according to claim 14 or 15.
[0036] According to this invention, with navigation equipment, while a car runs the road of two or more lanes, the slow lane is judged based on the distance and the width of road to a road edge. And the judged lane is collated with an optimal path and notifies a driver of the proper lane it should run based on the result. Therefore, since it is made to run the lane corresponding to an optimal path, attention of a driver can be called, and a comfortable navigation function can be realized.
[0037] the case where, as for said lane notice means, said judged slow lane does not agree into said proper lane in navigation equipment according to claim 16 in navigation equipment according to claim 17 -- this -- it is characterized by notifying of a proper lane.
[0038] According to this invention, the judged lane is collated with an optimal path by the same operation as invention according to claim 16, and when it is judged that it is not running the lane where a car is proper, a driver is notified of a proper lane. Therefore, avoiding the unnecessary notice at the time of running the proper lane, a necessary minimum notice is performed and a comfortable navigation function can be realized.
[0039] the case where, as for said lane notice means, said judged slow lane agrees into said proper lane in navigation equipment according to claim 16 in navigation equipment according to claim 18 -- this -- it is characterized by notifying of agreeing into a proper lane.
[0040] According to this invention, the judged lane is collated with an optimal path by the same operation as invention according to claim 16, and when [at which it is running the lane where a car is proper] judged, a driver is notified of that. Therefore, a driver is made to know running the proper lane and the comfortable navigation function to give sense of security to a driver can be realized.
[0041]
[Embodiment of the Invention] Hereafter, the gestalt of suitable operation of this invention is explained based on a drawing. In the gestalt of the following operations, the case where it applies to the navigation equipment in which this invention is carried by the car is explained.
[0042] Drawing 1 is drawing showing the outline configuration of the navigation equipment concerning this operation gestalt. The navigation equipment shown in drawing 1 is constituted including a control section 11, the map data storage section 12, the width-of-road data storage section 13, the sensor section 14, the current position detecting element 15, a display 16, a loudspeaker 17, the image-processing section 18, and CCD cameras 19a and 19b.
[0043] In the above configuration, a control section 11 controls actuation of the whole navigation equipment. A control section 11 outputs and inputs data while it reads and performs the control program which consists of a CPU etc. and is stored in ROM which is not illustrated and sends out a control signal to each component of navigation equipment.
[0044] The map data storage section 12 is memory with the big storage capacity which stores map data, for example, CD-ROM and DVD-ROM are used. The map data stored in the map data storage section 12 are constituted including road configuration data, name data, background data, etc.
[0045] The width-of-road data storage section 13 is memory recorded possible

[updating of the width-of-road data under car transit obtained in connection with the image processing concerning this invention]. Although simple width-of-road information is included also in the map data of the above-mentioned map data storage section 12, the width-of-road data memorized by the width-of-road data storage section 13 are still more detailed data, and are data which asked for the width of road which changes according to the location of a road correctly. In addition, about the generation method of width-of-road data, it mentions later.
[0046] The sensor section 14 contains various sensors required in order to detect the current position of a car. Specifically, it is constituted including the speed sensor which detects the rate of a car, the bearing sensor which detects the bearing variation of a car, the GPS receive section which receives the electric wave from a GPS (Global Positioning System) satellite.
[0047] Based on the output signal from the sensor section 14, the current position detecting element 15 computes the current position of a car, and outputs current position data. In addition, current position data are collated with the above-mentioned map data by the control section 11, and are amended by map matching processing etc.
[0048] Under directions of a control section 11, while map data are displayed in various modes, it superimposes on this and the current position of a car is displayed on a display 16 as a car mark. This display 16 consists of CRT, a liquid crystal display component, etc. Moreover, from a loudspeaker 17, while the induction information in alignment with the path of a car is outputted by voice, the below-mentioned guidance voice is outputted in relation to the image processing concerning this invention.
[0049] The image-processing section 18 is a means to perform the image processing which analyzes the picture signal from two sets of CCD cameras 19a and 19b installed in a car, and starts this operation gestalt. Here, the configuration and actuation of the image-processing section 18 are explained using drawing 2 .
[0050] As shown in drawing 2 , the image-processing section 18 is constituted including A/D converter 21, the 1st image memory 22, the 2nd image memory 23, the movement vector detecting element 24, and the movement vector processing section 25. Moreover, the image control section 18 operates according to the control signal from a control section 11. In addition, although the image-processing section 18 processes the picture signal from two sets of CCD cameras 19a and 19b like the after-mentioned in fact, since it is easy, it explains the case where the picture signal from one CCD camera19a is processed.
[0051] In drawing 2 , A/D converter 21 changes into a digital image signal the analog picture signal based on the image picturized by CCD camera 19a. Usually, the digital image signal outputted from A/D converter 21 constitutes one frame image data for every predetermined frame period, and consists of two or more continuous frame image data.
[0052] The 1st image memory 22 and the 2nd image memory 23 store the frame image data outputted from A/D converter 21, respectively. The 1st image memory 22 stores the newest frame image data, and the 2nd image memory 23 stores the frame image data in front of one. Therefore, in the image-processing section 18, the newest image data for two frames is always held, and the below-mentioned processing is performed using these.
[0053] The movement vector detecting element 24 detects the movement vector for every field in an image based on the frame image data stored in the 1st image memory

22 and the 2nd image memory 23. Under the present circumstances, the vehicle speed data outputted from the sensor section 14 are used.
[0054] Moreover, based on the movement vector detected by the movement vector detecting element 24, the movement vector processing section 25 asks for the distance to the road edge in a transit road, and the width of road based on this, and outputs them as width-of-road data etc.
[0055] In addition, about the detail of the processing in the movement vector detecting element 24 and the movement vector processing section 25, it mentions later.
[0056] Returning to drawing 1 , CCD cameras 19a and 19b are installed near the both ends ahead of a car, respectively, picturize the right-and-left side of a car, and output a picture signal. The installation condition to the car of CCD cameras 19a and 19b is shown in drawing 3 here.
[0057] Drawing 3 (a) is drawing showing the installation condition of CCD cameras 19a and 19b seen from the car upper part. As shown in drawing 3 (a), CCD cameras 19a and 19b are attached in the car-body upper part of right-and-left both sides at the car front side. CCD camera 19a is attached in car left-hand side, and CCD camera 19b is attached in car right-hand side, respectively. CCD camera 19a turns to the side on the left-hand side of a car, and is attached possible [an image pick-up], and CCD camera 19b turns to the side on the right-hand side of a car, is attached possible [an image pick-up], and is installed by respectively symmetrical arrangement.
[0058] Moreover, drawing 3 (b) is drawing showing the installation condition seen from the car front with the image pick-up range about CCD camera 19a. In addition, since it is easy, only the image pick-up condition in the case of on the left-hand side of a car is shown. As shown in drawing 3 (b), CCD camera 19a picturizes the range of the field angle theta toward a wall surface. Usually, it is attached in the include angle at which a path road surface is reflected in the lower part while a upside wall surface is reflected in the picturized image. In this invention, the distance DL to a left-hand side road edge is computed based on the image picturized by CCD camera 19a.
[0059] In addition, CCD camera 19a is attached in a location with a height [of a car] of about 1m. Moreover, in right-hand side CCD camera 19b, it will be in drawing 3 (b) and a symmetrical image pick-up condition, and it will compute the distance DR to a right-hand side road edge.
[0060] Next, the principle of the image processing concerning this operation gestalt is explained with reference to drawing 4 - drawing 8 .
[0061] Drawing 4 is drawing which expressed the image picturized by above-mentioned CCD cameras 19a and 19b with the model of a pinhole camera. In drawing 4 , the image plane P0 corresponding to the photo detector section of CCD camera 19a and the focal plane F corresponding to the lens section separate a focal distance f, and are arranged in parallel. The lens core C of a focal plane F corresponds to a pinhole, and considers a space-coordinates system (X, Y, Z) centering on this lens core C. On the other hand, by the image plane P0, camera system of coordinates (x y) are considered by setting space coordinates (0, 0, -f) as the image core c.
[0062] Here, the point M of a space-coordinates system (Xm, Ym, Zm) is considered. This point M can be made to correspond to the position on the wall surface in drawing 3 (b). Considering the central projection over this point M, even an image plane P0 is connected in a straight line through the lens core C of a focal plane F from Point M, and it is projected on the point m of camera system of coordinates (xm, ym). At this

time, the relation between Point M (Xm, Ym, Zm) and the projected point m (xm, ym) is expressed with a degree type.
[0063]
[Equation 1] xm = f-Xm/Zmym = It is drawing where drawing 5 expressed the relation between a space-coordinates system (X, Y, Z) and the pixel system of coordinates (u, v) of image data to the f-Ym/Zm order corresponding to drawing 4 . Since it is easy, while arranging the image plane P0 of drawing 4 to the front side of a focal plane F in drawing 5 , it considers as a pixel image system (u, v) by reversing the x axis of camera system of coordinates (x y), and the y-axis, respectively, and considering as u shaft and v shaft. Even if it transposes arrangement of drawing 4 to arrangement of drawing 5 , since it is mutually equivalent, the same relation is realized.
[0064] In drawing 5 , the image plane P1 of a pixel image system supports the display image of the horizontal number Nw of pixels, and the vertical number Nh of pixels, and the pixel of NwxNh is contained in an image plane P1 in all. On the other hand, this image plane P1 is in agreement with the light-receiving field of CCD cameras 19a and 19b with which size is set to Breadth w and height h. And if the point M of a space-coordinates system (X, Y, Z) is considered like drawing 4 , as shown in drawing 5 , it will be connected in a straight line to the lens core C of a focal plane F through the point m of an image plane P1 (u, v).
[0065] Here, considering the central projection over Point m, corresponding to several 1, the relation between Point M (X, Y, Z) and the projected point m (u, v) is expressed with a degree type like drawing 4 .
[0066]
[Equation 2] u = (f-X/Z) -Nw/wv = (f-Y/Z) -Nh/h, several 2 [i.e.,], expresses the pixel location in the image plane P1 of Point m (u, v). In several 2, u corresponds to a horizontal pixel location and v supports the vertical pixel location.
[0067] With this operation gestalt, since the image picturized from the car under transit is processed, it is necessary to assume a motion of the body in an image plane P1. Therefore, it is necessary to ask for the optical flow in an image plane P1, i.e., movement vector V, (u, v). When brightness I of the same point of three-dimension space is kept constant, the following differential equation between space-time is realized.
[0068]
[Equation 3]
dI/dt = Ix-u+Iy-v+It = It corrects zero and a partial differential with horizontal Ix and Iy are [a vertical partial differential and It of the partial differential of time amount shaft orientations, and u and v] the components of horizontal [of above-mentioned movement vector V], and a perpendicular direction in an image plane P1, respectively.
[0069] Next, how to ask for movement vector V using drawing 6 and drawing 7 is explained. As shown in drawing 6 , reference block R is defined in the image plane P1 in time of day t. With the upper left pixel pr as the starting point, this reference block R is the rectangle field of the range of n pixels, and contains the pixel of a mxn individual in u shaft in all at m pixels and v shaft. And an image plane P1 is divided into two or more reference block R, and each reference block R of every is asked for movement vector V. The example of drawing 6 shows reference block R used as m= 8

and n= 8.
[0070] Drawing 7 is drawing explaining how to ask for movement vector V to predetermined reference block R in an image plane P1. Drawing 7 corresponds to the image plane P1 in time-of-day t+delta t in which deltat has passed since the time of day t of drawing 6 . And based on the vehicle speed data from the sensor section 14 etc., the predetermined field in an image plane P1 is beforehand appointed as search range S. The search range S is a rectangle field where it becomes M pixels on u shaft, and it becomes v shaft with N pixel, and M and N usually become sufficiently large compared with m and n.
[0071] And comparison Brock C of reference block R and the same size is defined as a position to the search range S. Since size is sufficiently large compared with reference block R, it is necessary, as for the search range S, to move comparison Brock's C location little by little in the search range S. By drawing 7 , comparison Brock C is the size of mxn like reference block R, and shows the pixel pc at the upper left of comparison Brock C corresponding to the pixel pr at the upper left of a reference block. The pixel at the upper left of the search range S is set as comparison Brock's C pixel pc at first, after that, in the search range S, it moves 1 pixel of locations of Pixel pc at a time to u shaft orientations or v shaft orientations, and the below-mentioned operation is performed about all comparison Brock C that can give a definition in the search range S.
[0072] Subsequently, a correlation value is calculated among comparison Brock C in reference block R in the time of day t of drawing 6 , and time-of-day t+delta t of drawing 7 . Here, in the image data which is the set of a pixel, since the concentration value is made to correspond to all the pixels of a mxn individual, it asks for the difference of the concentration value for every pixel to which reference block R and comparison Brock C correspond. A correlation value is calculable if the sum about the pixel of a mxn individual is taken to the difference for every pixel of this concentration value.
[0073] And to reference block R, the correlation value between all comparison Brock C in the search range S is calculated, and it looks for comparison Brock C who gives the minimum correlation value. For example, suppose that comparison Brock C who shows drawing 7 gives the minimum correlation value.
[0074] In this case, as shown in drawing 7 , in an image plane P1, the vector which turns on comparison Brock C in time-of-day t+delta t from reference block R in the time of day t shown by the dotted line can be determined as movement vector V.
[0075] Although drawing 7 showed only one movement vector V, it asks for movement vector V in fact about all reference block R which can be defined as an image plane P1. This searches for spatial distribution of movement vector V. And the below-mentioned processing is performed based on spatial distribution of this movement vector V.
[0076] Next, the above-mentioned distance DR and DL and the calculation approach of the width of road are explained using drawing 8 . Drawing 8 is drawing showing an example of distribution of movement vector V in the image picturized from CCD camera19a. In drawing 8 , since it is easy, in the longitudinal direction of a car, the case where the path road surface and the wall surface have touched in the boundary section 30 is assumed like drawing 3 (b). Moreover, distribution of movement vector V on Rhine L1 in time of day t is considered.

[0077] As shown in drawing 8 , in the image picturized in CCD camera 19a, the magnitude of movement vector V is changing with the rate of change of abbreviation regularity by the path road surface in the lower part of the boundary section 30 to the magnitude of movement vector V serving as constant value on the wall surface in the upper part of the boundary section 30. Thus, the magnitude of movement vector V serves as a value depending on the distance z to a photography object.
[0078] That is, supposing it performs the image pick-up by CCD camera 19a by frame period T in the car it is running at a rate v0 (m/second), the migration length d of a 1 inter-frame car is [0079].
[Equation 4] d = v0andT (m)
It can express. Here, if a photography object considers the situation which does not change only in the direction of u in a motion, the direction of v, and the direction of z relatively [car], the following formulas will be realized that what is necessary is several 2 just to substitute above-mentioned x=d.
[0080]
[Equation 5] u = (f-d/z) -Nw/w = (f-v0.T/z) It can express -Nw/w. Movement vector V (u, 0) becomes settled by u shown in several 5, and this u is in agreement with the magnitude of movement vector V. Thus, the magnitude of movement vector V is in inverse proportion to the distance z with a photography object.
[0081] Drawing 9 is drawing in which the magnitude of movement vector V of Rhine L1 shows signs that it changes corresponding to several 5. In drawing 9 , while a continuous line shows the magnitude of the movement vector of a photography object to v shaft in the image of drawing 8 , the dotted line shows distance z. Since distance z becomes fixed, on a wall surface, it becomes fixed [the magnitude of movement vector V], so that drawing 8 may show. On the other hand, since it becomes small at a rate of abbreviation regularity so that distance z goes by the path road surface caudad, several 5 u becomes large linearly.
[0082] Therefore, in drawing 9 , movement vector V cannot change with the rate of change of abbreviation regularity, but can distinguish a wall surface and a path road surface based on whether it becomes in general fixed, and can also judge the location of the boundary section 30. And MV (pixel), then the distance DL to the above-mentioned wall surface are based on several 5 in the average of movement vector V of a wall surface, and it is [0083].
[Equation 6]
DL = (f-v0.T/MV) -Nw/w can be computed and calculated.
[0084] In addition, although movement vector V becomes small with the rate of change of abbreviation regularity as it goes above an image by the path road surface when a slot exists in a road edge, on the boundary of a path road surface and a slot, it changes uniformly [rate of change] and rapidly partially. Therefore, a slot can be detected by distinguishing this break point, and the distance DL to a road edge can be found based on the magnitude of movement vector V before and behind that.
[0085] Moreover, what is necessary is to generate two or more fields where movement vector V becomes in general fixed, when becoming a partial wall surface like the guard rail instead of a single wall surface, but just to use the distance DL which finds the distance DL about two or more fields, among those serves as the shortest, while detecting a break point as mentioned above. Also when a guard rail adjoins a road edge, the distance DL of a road edge can be found based on the distance to the field

corresponding to a guard rail.
[0086] In addition, as an example of each numeric value in several 5, it becomes focal distance f= 4 (mm), horizontal pixel number Nw=320 (pixel), and breadth [of a light-receiving field] w=4(mm) frame period T=1 / 30 (second) extent. .
[0087] If the above image processing is similarly performed to the image by two CCD cameras 19a and 19b, the distance DL and DR to the road edge in right and left of a car will be found. Therefore, while adding these, in consideration of the breadth of a car, the width of road in the road under transit is further computable. For example, when a car has Breadth W in the installation condition of drawing 2 (b), the width of road RW is [0088].
[Equation 7] RW ** It can ask in approximation with DL+DR+W.
[0089] In addition, if the width-of-road data corresponding to the computed width of road RW are related with map data and memorized possible [updating] in the width-of-road data storage section 13, it can use for various kinds of below-mentioned processings.
[0090] Next, the concrete image processing in the navigation equipment concerning this operation gestalt is explained with reference to drawing 10 and drawing 11 . Drawing 10 is a flow chart which shows processing for the car under transit to prevent approaching a road edge, and drawing 11 is a flow chart which shows processing for the car under transit the road of two or more lanes to make it run a proper lane to a setting path. In addition, drawing 10 and drawing 11 are processings mainly performed according to control of a control section 11.
[0091] If the processing shown in drawing 10 is started, the distance DL and DR to the road edge of both sides will be found, and the width of road RW will be computed by processing of the above image-processing sections 18 according to several 7 based on this (step S1). And the width-of-road data corresponding to the width of road RW computed at step S1 are related with map data, and are written in the width-of-road data storage section 13 (step S2). At this time, it may be made to write in width-of-road data in the predetermined point path on the street set up beforehand.
[0092] Subsequently, based on the distance DL and DR acquired in step S1, it is judged whether the car under transit visits a road edge too much (step S3). namely, what is necessary is to set up a predetermined distance used as criteria, and just to judge that a car visits a road edge too much and comes out to it, when distance DL or DR serves as a small value from this predetermined distance
[0093] When the decision result of step S3 is "YES", a car visits a road edge too much, and comes out to it, and it warns a driver of a certain thing (step S4). For example, what is necessary is just to output as voice the predetermined message which visits a road edge too much, comes out to it, and shows a certain purport from a loudspeaker 17. Or the same message or a display notation may be displayed on a display 16.
[0094] After finishing step S4 when the decision result of step S3 is "NO" or, it judges whether a car is running or not (step S5). When a car is not running (step S5; NO), since it is not necessary to perform an image processing, processing is finished. On the other hand, when a car is still running (step S5; YES), processing of step S1 - step S5 is repeated.
[0095] In navigation equipment, real time can be asked for the always exact width of road RW by processing the above step S1 - step S5. And since it was made to warn a

driver when the distance DL and DR to a road edge was supervised and the car under transit visited a road edge too much, operation of a driver can be assisted and the insurance under transit can be secured. Moreover, since width-of-road data were suitably written in the width-of-road data storage section 13, when running the behind same road, it becomes possible to utilize width-of-road data effectively.

[0096] Next, the desired destination is set as navigation equipment and processing shown in drawing 11 is performed under the situation that a path is judged. First, like step S1, the distance DL and DR to the road edge of both sides is found, and the width of road RW is computed further (step S11).

[0097] And the lane information over the lane under transit included in the map data of the map data storage section 12 is read (step S12). Since the road under transit is the information which shows **** with what lane, this lane information judges whether the roads under transit are two or more lanes based on lane information (step S13).

[0098] When the decision result of step S13 is "YES", based on the decision result of step S11, it judges which lane is under transit among two or more lanes now (step S14). This judgment can be performed based on a ratio with the distance DL and DR to the road edge of the both sides of the car for which it asked at step S1.

[0099] Then, the lane judged at step S14 judges whether it is a proper lane corresponding to the path which arrives at the destination (step S15). That is, if the case where it is running the road of three lanes, for example is taken for an example, you may be which lane when a right-hand side lane becomes proper when turning to the right ahead generally, a left-hand side lane serves as fitness when turning left ahead, and going straight on as it is. Or the information on the proper lane at the time of left turn and right-turn may be set up beforehand.

[0100] As a result of the judgment of step S15, when the car is running the proper lane, processing (step S15; YES) is finished. On the other hand, when the car is running the lane which is not proper, guidance of lane modification is directed to (step S15; NO) and a driver (step S16). for example, the case where it is running the left-hand side lane before the right-turn point -- already -- what is necessary is to output as voice the message of a purport which urges moving to 2 lane right to a driver from a loudspeaker 17, or just to display it on a display 16

[0101] In navigation equipment, the lane in which a car is located by the road of two or more lanes can be judged on real time by processing the above step S11 - step S16. And unnecessary guidance does not need to be performed, when guidance is performed only when required and it has already run the proper lane, since it was made to guide lane modification to a driver only when it was not located in a proper lane, in order to perform right-turn, left turn, etc. Therefore, convenience is high and much more comfortable navigation becomes realizable for a driver.

[0102] In addition, in the example of drawing 11 , only while the car is running the lane which is not proper, when directing guidance of lane modification, namely, while running the proper lane, the case where guidance of lane modification was not directed was explained, but it is not restricted to this, but while [when a car is proper] running, it may be made to perform a certain guidance. For example, while running a proper lane, guidance of "please maintain the lane of this as" may be outputted with voice etc. Thereby, the driver under operation can be made to be able to grasp running the proper lane, and sense of security can be given to it.

[0103] As mentioned above, although this invention was explained based on the operation gestalt, this invention is not limited to the above-mentioned operation gestalt at all, and it can guess it easily for amelioration deformation various by within the limits which does not deviate from the meaning of this invention to be possible.
[0104] For example, you may make it display the image picturized with CCD cameras 19a and 19b as an image pick-up means on a display 16. With this operation gestalt, since it is installed so that CCD cameras 19a and 19b may picturize the just beside direction in the car front, before a driver arrives at the location which can see the side directly, on a display 16, a side image is checked by looking and the thing of it can be carried out. Especially when a car advances into a crossing from a narrow alley, a side image can be checked by looking only by taking out a car tip to a crossing slightly, and it becomes useful at insurance transit of a car.
[0105] Moreover, although the above-mentioned operation gestalt explained the case where it was installed so that CCD cameras 19a and 19b as an image pick-up means may picturize the just beside direction in the side of a car, it is not restricted to this, but you may install so that the direction of before [slant] approach in the side of a car may be picturized. Thereby, a side image can be preceded in time, and can be processed and the distance to a road edge can be found timely.
[0106] Or you may install so that the direction [in / for CCD cameras 19a and 19b / the side of a car] of the bottom approach of slant may be picturized. Generally, if CCD cameras 19a and 19b with a vertical narrow field angle are used, when a car approaches a road edge, the case where a road edge stops entering in an image will arise. in such a case, since it comes out, and a road edge will enter in an image if the image pick-up direction of CCD cameras 19a and 19b comes together the bottom and there comes out and is even if it is, it becomes possible to find the distance to a road edge.
[0107] Moreover, CCD cameras 19a and 19b which have a larger field angle may be used. For example, when a horizontal field angle performs above-mentioned processing separately to the left-hand side field and the right-hand side field in each image pick-up image using some CCD cameras 19a and 19b about 180 degrees, the distance to a road edge may be found. The distance to a road edge can be found thereby still more finely.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the outline configuration of the navigation equipment concerning this operation gestalt.
[Drawing 2] It is drawing showing the configuration of the image-processing section of navigation equipment.
[Drawing 3] It is drawing showing the installation condition to the car of a CCD camera, and the installation condition which looked at (a) from the car upper part, and (b) are drawings showing a right-hand side installation condition from the car front, respectively.
[Drawing 4] It is drawing which expressed the image picturized by the CCD camera with the model of a pinhole camera.
[Drawing 5] It is drawing showing the relation between a space-coordinates system and the pixel system of coordinates of image data.
[Drawing 6] In case it asks for a movement vector, it is drawing explaining the reference block defined in an image plane.
[Drawing 7] It is drawing explaining how to define comparison Brock as search within the limits, and to ask for a movement vector from the predetermined reference block in an image plane.
[Drawing 8] In the image processing concerning this operation gestalt, it is drawing explaining the distance to a road edge, and the calculation approach of the width of road.
[Drawing 9] It is drawing explaining signs that the magnitude of the movement vector in an image and distance with a wall surface change.
[Drawing 10] In the navigation equipment concerning this operation gestalt, it is the flow chart which shows the processing for preventing that the car under transit approaches a road edge corresponding to width-of-road detection.
[Drawing 11] In the navigation equipment concerning this operation gestalt, it is the flow chart which shows processing for a car while running the road of two or more lanes to make it run a proper lane to a setting path corresponding to width-of-road detection.
[Description of Notations]
11 -- Control section
12 -- Map data storage section
13 -- Width-of-road data storage section
14 -- Sensor section

15 -- Current position detecting element
16 -- Display
17 -- Loudspeaker
18 -- Image-processing section
19a, 19b -- CCD camera
21 -- A/D converter
22 -- The 1st image memory
23 -- The 2nd image memory
24 -- Movement vector detecting element
25 -- Movement vector processing section

[Translation done.]

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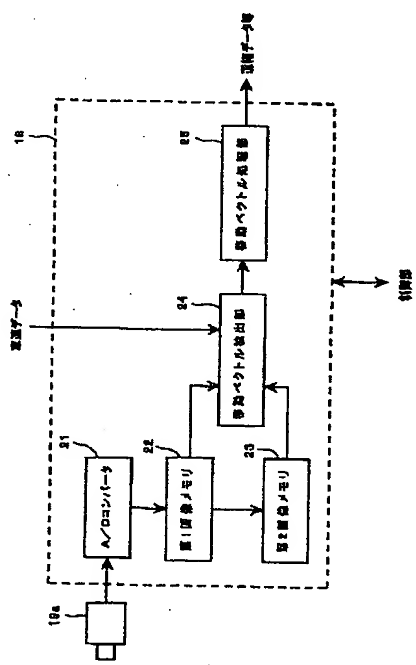
(71)出願人　000005016
パイオニア株式会社
東京都目黒区目黒1丁目4番1号
(72)発明者　柏崎　隆
埼玉県川越市大字山田字西町25番地1　パイオニア株式会社川越工場内
(74)代理人　100083839
弁理士　石川　泰男

最終頁に続く

(54)【発明の名称】　画像処理装置、画像処理方法及びナビゲーション装置

(57)【要約】
【課題】　走行中の車両から側方を撮像して画像処理を行うことにより、走行車両の安全を保つと共に、道幅データを取得可能な車載用画像処理装置及び車載用ナビゲーション装置を提供する。
【解決手段】　車両側方を撮像するＣＣＤカメラ１９ａからの画像信号は、ナビゲーション装置に含まれる画像処理部１８に入力され、Ａ／Ｄコンバータ２１によりディジタル画像信号に変換され、所定のフレーム周期を持つフレーム画像データとなる。連続する２つのフレーム画像データは、それぞれ第１画像メモリ２２及び第２画像メモリ２３に格納される。移動ベクトル検出部２４では、これらのフレーム画像データと車速データに基づき画像の各領域の移動ベクトルを検出し、移動ベクトル処理部２５では、移動ベクトルに基づき道路端までの距離を求める。更に、この距離により走行道路の道幅が算出される。これにより、道路端への近接時にドライバーに警告したり、走行車線を判定して変更案内をしたり、道幅データを記憶して後に有効活用するなど、車両の安全性と利便性を高めることができる。



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【特許請求の範囲】
【請求項1】 移動体の側方を撮像して画像信号を出力する撮像手段と、
移動体が移動中の前記画像信号に基づいて、撮像された画像のそれぞれの領域ごとに、移動ベクトルを検出する移動ベクトル検出手段と、
前記検出された移動ベクトルの大きさの空間的変化率を判別し、該変化率に基づいて道路端までの距離を算出する距離算出手段と、
を備えることを特徴とする画像処理装置。
【請求項2】 前記撮像手段は、移動体の左側側方を撮像する第1の撮像手段と、移動体の右側側方を撮像する第2の撮像手段とを含み、前記距離算出手段は、左側道路端までの第1の距離と、右側道路端までの第2の距離とを算出することを特徴とする請求項1に記載の画像処理装置。
【請求項3】 前記第1の距離及び前記第2の距離に基づいて、移動体の走行道路の道幅を算出する道幅算出手段を更に備えることを特徴とする請求項2に記載の画像処理装置。
【請求項4】 前記画像信号は、所定のフレーム周期を持つフレーム画像データを単位として構成され、前記移動ベクトル検出手段は、連続する2つのフレーム画像データに基づいて前記移動ベクトルを検出することを特徴とする請求項1から請求項3のいずれかに記載の画像処理装置。
【請求項5】 前記撮像手段は、移動体の前側に設置されていることを特徴とする請求項1から請求項4のいずれかに記載の画像処理装置。
【請求項6】 前記撮像手段は、移動体の斜め前寄りの側方を撮像することを特徴とする請求項1から請求項5のいずれかに記載の画像処理装置。
【請求項7】 前記撮像手段は、移動体の斜め下寄りの側方を撮像することを特徴とする請求項1から請求項6のいずれかに記載の画像処理装置。
【請求項8】 移動体の側方を撮像する撮像手段から出力された画像信号に基づいて画像処理を行う画像処理方法であって、
移動体が移動中の前記画像信号に基づいて、撮像された画像のそれぞれの領域ごとに、移動ベクトルを検出する移動ベクトル検出工程と、
前記検出された移動ベクトルの大きさの空間的変化率を判別し、該変化率に基づいて道路端までの距離を算出する距離算出工程と、
を備えることを特徴とする画像処理方法。
【請求項9】 前記画像信号は、移動体の左側側方を撮像する第1の撮像手段、及び、移動体の右側側方を撮像する第2の撮像手段からそれぞれ出力され、前記距離算出工程は、左側道路端までの第1の距離と、右側道路端までの第2の距離とを算出することを特徴とする請求項8に記載の画像処理方法。

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【請求項10】 前記第1の距離及び前記第2の距離に基づいて、移動体の走行道路の道幅を算出する道幅算出工程を更に備えることを特徴とする請求項9に記載の画像処理方法。
【請求項11】 前記画像信号は、所定のフレーム周期を持つフレーム画像データを単位として構成され、前記移動ベクトル検出工程は、連続する2つのフレーム画像データに基づいて前記移動ベクトルを検出することを特徴とする請求項8から請求項10のいずれかに記載の画像処理方法。
【請求項12】 地図データに基づいて車両の現在位置から目的地までの経路案内を行うナビゲーション装置であって、
車両の移動速度を検出する車速センサを含むセンサ部と、
車両の側方を撮像して画像信号を出力する撮像手段と、
車両走行中の前記画像信号に基づいて、撮像された画像のそれぞれの領域ごとに、移動ベクトルを検出する移動ベクトル検出手段と、
前記検出された移動ベクトルの大きさの空間的変化率を判別し、該変化率及び前記移動速度に基づいて道路端までの距離を算出する距離算出手段と、
を備えることを特徴とするナビゲーション装置。
【請求項13】 前記算出された距離が予め設定された値より小さい場合、車両が道路端に近接したことを告知する告知手段を更に備えることを特徴とする請求項12に記載のナビゲーション装置。
【請求項14】 前記算出された距離に基づいて、車両の走行道路の道幅を算出する道幅算出手段を更に備えることを特徴とする請求項12又は請求項13に記載のナビゲーション装置。
【請求項15】 前記算出された道幅に対応する道幅データを前記地図データと関連づけて更新可能に記憶する道幅データ記憶手段を更に備えることを特徴とする請求項14に記載のナビゲーション装置。
【請求項16】 前記距離算出手段と前記道幅算出手段の算出結果に基づいて車両の走行車線を判定する走行車線判定手段と、
前記判定された走行車線を前記目的地までの最適経路と照合して、該照合結果に基づいて走行すべき適正な車線を告知する車線告知手段と、
を更に備えることを特徴とする請求項14又は請求項15に記載のナビゲーション装置。
【請求項17】 前記車線告知手段は、前記判定された走行車線が前記適正な車線に合致しない場合、該適正な車線を告知することを特徴とする請求項16に記載のナビゲーション装置。
【請求項18】 前記車線告知手段は、前記判定された走行車線が前記適正な車線に合致する場合、該適正な車

線に合致することを告知することを特徴とする請求項１６に記載のナビゲーション装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、走行中の車両において、撮像手段からの画像信号に基づいて道路端までの距離及び道幅を求める画像処理装置、画像処理方法及びナビゲーション装置の技術分野に属する。

【０００２】

【従来の技術】従来から、移動体としての車両の現在位置を検出し、周辺の道路地図と共に検出された現在位置を表示画面に表示して経路案内を行うナビゲーション装置が広く用いられている。この種のナビゲーション装置においては、地図データが記憶された大容量の記録媒体を備えており、表示画面上の表示データを生成するために用いられる。記録媒体上の地図データには、道路形状に関するデータや表示用の各種データなどに加え、これに付随する道幅情報が含まれる。よって、走行中の道路に対応する道幅情報を読み出して、現在走行している道路の道幅を把握することができる。

【０００３】

【発明が解決しようとする課題】しかしながら、上記従来のナビゲーション装置では、地図データに含まれる道幅情報は正確な道幅を示すものではなく、例えば５．５ｍ～８ｍのように、その道路の概略の道幅を示すに過ぎなかった。よって、道路のポイントに対応したきめ細かく正確な道幅情報は取得することができなかった。更に、単に道路の道幅を知るだけではなく、道路までの距離をリアルタイムに求め、これを車両の安全走行に役立てることへのニーズも強くなっている。

【０００４】そこで、本発明はこのような問題に鑑みなされたものであり、走行中の車両から撮像した画像に基づいて、壁面や溝、あるいは道路面に隣接する道路面以外の構造物を画像中から検出することにより、道路端までの距離及び道幅を求めることができる車載用画像処理装置、及び、画像処理の結果に応じて、ドライバーに対し安全走行を確保するための警告や案内を行うことが可能なナビゲーション装置を提供することを目的とする。

【０００５】

【課題を解決するための手段】上記課題を解決するために、請求項１に記載の画像処理装置は、移動体の側方を撮像して画像信号を出力する撮像手段と、移動体が移動中の前記画像信号に基づいて、撮像された画像のそれぞれの領域ごとに、移動ベクトルを検出する移動ベクトル検出手段と、前記検出された移動ベクトルの大きさの空間的変化率を判別し、該変化率に基づいて道路端までの距離を算出する距離算出手段とを備えることを特徴とする。

【０００６】この発明によれば、画像処理装置により、走行中の車両等の移動体において側方に向けて撮像手段による撮像が行われて画像信号が出力される。この画像信号を２つの時点で比較して、それぞれの領域ごとの移動ベクトルが検出される。画像中の道路面等の水平部分では移動ベクトルの変化率が略一定となるが、道路端では変化率の不連続点が生じる。よって、これら領域ごとに区別して道路端を判別でき、更に移動ベクトルの大きさに基づき道路端までの距離が算出できる。従って、算出された距離は、走行中の安全確保やナビゲーションの支援等の用途に利用可能であり、車両の安全性と利便性を高めることができる。

【０００７】請求項２に記載の画像処理装置は、請求項１に記載の画像処理装置において、前記撮像手段は、移動体の左側側方を撮像する第１の撮像手段と、移動体の右側側方を撮像する第２の撮像手段とを含み、前記距離算出手段は、左側道路端までの第１の距離と、右側道路端までの第２の距離とを算出することを特徴とする。

【０００８】この発明によれば、走行中の車両等の移動体では、左側に向けて第１の撮像手段が、右側に向けて第２の撮像手段がそれぞれ撮像を行って画像信号を出力する。その後の処理は請求項１に記載の発明と同様に、右側の画像と左側の画像について行われ、移動体の両側道路端までの距離が算出できる。従って、算出された２つの距離を取得して走行道路における車両位置の把握が容易となり、車両の安全性と利便性を一層高めることができる。

【０００９】請求項３に記載の画像処理装置は、請求項２に記載の画像処理装置において、前記第１の距離及び前記第２の距離に基づいて、移動体の走行道路の道幅を算出する道幅算出手段を更に備えることを特徴とする。

【００１０】この発明によれば、車両等の移動体における左右の画像に対応して算出された２つの距離に基づいて、走行道路の道幅を算出できる。例えば、撮像手段が車両両側の側部に設置されている場合、２つの距離を加え、更に撮像手段の間の距離を加えれば道幅が得られる。従って、この道幅を用いて走行中の安全を確保したり、道幅データを取得するなど、車両の安全確保とナビゲーションの機能向上に有用となる。

【００１１】請求項４に記載の画像処理装置は、請求項１から請求項３のいずれかに記載の画像処理装置において、前記画像信号は、所定のフレーム周期を持つフレーム画像データを単位として構成され、前記移動ベクトル検出手段は、連続する２つのフレーム画像データに基づいて前記移動ベクトルを検出することを特徴とする。

【００１２】この発明によれば、画像処理の対象は、フレーム周期ごとに出力されるフレーム画像データであり、連続する２つのフレーム画像データを用いて上述の画像処理が行われる。従って、車両の走行中に常にリアルタイムに画像処理が行われ、車両の状況に迅速に対応可能な画像処理装置を実現できる。

【００１３】請求項５に記載の画像処理装置は、請求項

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１から請求項４のいずれかに記載の画像処理装置において、前記撮像手段は、移動体の前側に設置されていることを特徴とする。

【００１４】この発明によれば、移動体の前側に設置された撮像手段からの画像信号を例えば表示画面に表示することにより、上記の作用に加えて、通常は視認が困難である移動体前側の横方向を容易に視認することでき、車両の安全確保に一層有用となる。

【００１５】請求項６に記載の画像処理装置は、請求項１から請求項５のいずれかに記載の画像処理装置において、前記撮像手段は、移動体の斜め前寄りの側方を撮像することを特徴とする。

【００１６】この発明によれば、移動体の斜め前寄りを撮像する撮像手段からの画像信号に基づいて上述の処理を行うようにしたので、車両の進行方向前方における道路端までの距離を時間的に先行して算出でき、迅速に車両の走行状態を把握することができる。

【００１７】請求項７に記載の画像処理装置は、請求項１から請求項６のいずれかに記載の画像処理装置において、前記撮像手段は、移動体の斜め下寄りの側方を撮像することを特徴とする。

【００１８】この発明によれば、移動体の斜め下寄りを撮像する撮像手段からの画像信号に基づいて上述の処理を行うようにしたので、道路端に近接した場合であっても画角内に道路端を捉えやすくなり、走行車両の安全性を更に高めることができる。

【００１９】請求項８に記載の画像処理方法は、移動体の側方を撮像する撮像手段から出力された画像信号に基づいて画像処理を行う画像処理方法であって、移動体が移動中の前記画像信号に基づいて、撮像された画像のそれぞれの領域ごとに、移動ベクトルを検出する移動ベクトル検出工程と、前記検出された移動ベクトルの大きさの空間的変化率を判別し、該変化率に基づいて道路端までの距離を算出する距離算出工程とを備えることを特徴とする。

【００２０】この発明によれば、走行中の車両等の移動体に設置された撮像手段からの画像信号を入力し、請求項１に記載の発明と同様の作用により、道路端を判別でき、更に移動ベクトルの大きさに基づき道路端までの距離が算出できる。従って、算出された距離は、走行中の安全確保やナビゲーションの支援等の用途に利用可能であり、車両の安全性と利便性を高めることができる。

【００２１】請求項９に記載の画像処理方法は、請求項８に記載の画像処理方法において、前記画像信号は、移動体の左側側方を撮像する第１の撮像手段、及び、移動体の右側側方を撮像する第２の撮像手段からそれぞれ出力され、前記距離算出工程は、左側道路端までの第１の距離と、右側道路端までの第２の距離とを算出することを特徴とする。

【００２２】この発明によれば、走行中の車両等の移動体に設置された第１の撮像手段からの左側側方に対応する画像信号と、第２の撮像手段からの右側側方に対応する画像信号をそれぞれ入力し、請求項２に記載の発明と同様の作用により、移動体の両側道路端までの距離が算出できる。従って、算出された２つの距離を取得して走行道路における車両位置の把握が容易となり、車両の安全性と利便性を一層高めることができる。

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【００２３】請求項１０に記載の画像処理方法は、請求項９に記載の画像処理方法において、前記第１の距離及び前記第２の距離に基づいて、移動体の走行道路の道幅を算出する道幅算出工程を更に備えることを特徴とする。

【００２４】この発明によれば、請求項３に記載の発明と同様の作用により、走行道路の道幅を算出でき、この道幅を用いて走行中の安全を確保したり、道幅データを取得するなど、車両の安全確保とナビゲーションの機能向上に有用となる。

【００２５】請求項１１に記載の画像処理方法は、請求項８から請求項１０のいずれかに記載の画像処理方法において、前記画像信号は、所定のフレーム周期を持つフレーム画像データを単位として構成され、前記移動ベクトル検出工程は、連続する２つのフレーム画像データに基づいて前記移動ベクトルを検出することを特徴とする。

【００２６】この発明によれば、請求項４に記載の発明と同様の作用により、連続する２つのフレーム画像データを用いて上述の画像処理が行われるので、車両の走行中に常にリアルタイムに画像処理が行われ、車両の状況に迅速に対応可能な画像処理方法を提供できる。

【００２７】請求項１２に記載のナビゲーション装置は、地図データに基づいて車両の現在位置から目的地までの経路案内を行うナビゲーション装置であって、車両の移動速度を検出する車速センサを含むセンサ部と、車両の側方を撮像して画像信号を出力する撮像手段と、車両走行中の前記画像信号に基づいて、撮像された画像のそれぞれの領域ごとに、移動ベクトルを検出する移動ベクトル検出手段と、前記検出された移動ベクトルの大きさの空間的変化率を判別し、該変化率及び前記移動速度に基づいて道路端までの距離を算出する距離算出手段とを備えることを特徴とする。

【００２８】この発明によれば、ナビゲーション装置のセンサ部によって車両の移動速度が検出されると共に、車両側方に向けて撮像手段による撮像が行われて画像信号が出力される。そして、請求項１に記載の発明と同様の作用による画像処理が行われる。従って、算出された距離は、安全性の確保やその他の各種機能に有効に活用でき、車両の安全性と利便性を高めることができる。

【００２９】請求項１３に記載のナビゲーション装置は、請求項１２に記載のナビゲーション装置において、前記算出された距離が予め設定された値より小さい場

合、車両が道路端に近接したことを告知する告知手段を更に備えることを特徴とする。

【0030】この発明によれば、ナビゲーション装置では、道路端までの距離に基づいて、車両が道路端に近接し過ぎたことを判定し、その旨をドライバーに告知するようにしたので、車両の安全性と利便性を一層高めることができる。

【0031】請求項14に記載のナビゲーション装置は、請求項12又は請求項13に記載のナビゲーション装置において、車両の走行道路の道幅を算出する道幅算出手段を更に備えることを特徴とする。

【0032】この発明によれば、走行する車両では、走行道路の道幅を算出でき、例えば、撮像手段が車両両側の側部に設置されている場合、2つの距離を加え、更に車両の幅を加えれば道幅が得られる。従って、この道幅を用いて走行中の安全を確保したり、道幅データを取得して地図データと関連づけて保持するなど、車両の安全確保とナビゲーションの機能向上に有用となる。

【0033】請求項15に記載のナビゲーション装置は、請求項14に記載のナビゲーション装置において、前記算出された道幅に対応する道幅データを前記地図データと関連づけて更新可能に記憶する道幅データ記憶手段を更に備えることを特徴とする。

【0034】この発明によれば、車載用ナビゲーション装置では、道幅データ記憶手段に上述のように求めた道幅に対応する道幅データを更新可能に記憶する。従って、車両が走行した道路の道幅データを保持し、その後、再び同じ道路を通ったときに活用できるので、ナビゲーション装置の機能を支援することができる。

【0035】請求項16に記載のナビゲーション装置は、請求項14又は請求項15に記載のナビゲーション装置において、前記距離算出手段と前記道幅算出手段の算出結果に基づいて車両の走行車線を判定する走行車線判定手段と、前記判定された走行車線を前記目的地までの最適経路と照合して、該照合結果に基づいて走行すべき適正な車線を告知する車線告知手段とを更に備えることを特徴とする。

【0036】この発明によれば、ナビゲーション装置では、車両が複数車線の道路を走行中に、道路端までの距離及び道幅に基づき走行車線を判定する。そして、判定された車線が最適経路と照合されて、その結果に基づき走行すべき適正な車線をドライバーに告知する。従って、最適経路に対応する車線を走行させるためドライバーの注意を喚起することができ、快適なナビゲーション機能を実現できる。

【0037】請求項17に記載のナビゲーション装置は、請求項16に記載のナビゲーション装置において、前記車線告知手段は、前記判定された走行車線が前記適正な車線に合致しない場合、該適正な車線を告知することを特徴とする。

【0038】この発明によれば、請求項16に記載の発明と同様の作用により、判定された車線が最適経路と照合され、車両が適正な車線を走行していないと判断されたとき、適正な車線をドライバーに告知する。よって、適正な車線を走行している際の不要な告知を回避しつつ、必要最小限の告知を行って、快適なナビゲーション機能を実現できる。

【0039】請求項18に記載のナビゲーション装置は、請求項16に記載のナビゲーション装置において、前記車線告知手段は、前記判定された走行車線が前記適正な車線に合致する場合、該適正な車線に合致することを告知することを特徴とする。

【0040】この発明によれば、請求項16に記載の発明と同様の作用により、判定された車線が最適経路と照合され、車両が適正な車線を走行している判断されたとき、その旨をドライバーに告知する。よって、適正な車線を走行していることをドライバーに知らしめて、ドライバーに安心感を与える快適なナビゲーション機能を実現できる。

【0041】

【発明の実施の形態】以下、本発明の好適な実施の形態を図面に基づいて説明する。以下の実施の形態においては、本発明を車両に搭載されるナビゲーション装置に適用した場合について説明する。

【0042】図1は、本実施形態に係るナビゲーション装置の概略構成を示す図である。図1に示すナビゲーション装置は、制御部11と、地図データ記憶部12と、道幅データ記憶部13と、センサ部14と、現在位置検出部15と、ディスプレイ16と、スピーカ17と、画像処理部18と、CCDカメラ19a、19bとを含んで構成されている。

【0043】以上の構成において、制御部11は、ナビゲーション装置全体の動作を制御する。制御部11はCPU等からなり、図示しないROMに格納される制御プログラムを読み出して実行し、ナビゲーション装置の各構成要素に制御信号を送出すると共に、データを入出力する。

【0044】地図データ記憶部12は、地図データを格納する記憶容量の大きなメモリであり、例えばCD－ROMやDVD－ROMが用いられる。地図データ記憶部12に格納される地図データは、道路形状データ、名称データ、背景データなどを含んで構成される。

【0045】道幅データ記憶部13は、本発明に係る画像処理に伴って得られた車両走行中の道幅データを更新可能に記録するメモリである。上述の地図データ記憶部12の地図データにも簡易な道幅情報が含まれるが、道幅データ記憶部13に記憶される道幅データは更に詳細なデータであり、道路の位置に応じて変化する道幅を正確に求めたデータである。なお、道幅データの生成方法については後述する。

【0046】センサ部14は、車両の現在位置を検出するために必要な各種センサを含んでいる。具体的には、車両の速度を検出する車速センサや、車両の方位変化量を検出する方位センサや、GPS（Global Positioning System）衛星からの電波を受信するGPS受信部などを含んで構成される。

【0047】現在位置検出部15は、センサ部14からの出力信号に基づいて、車両の現在位置を算出し、現在位置データを出力する。なお、現在位置データは、制御部11によって前述の地図データと照合されて、マップマッチング処理等により補正される。

【0048】ディスプレイ16には、制御部11の指示の下、地図データが種々の態様で表示されると共に、これに重畳して車両の現在位置がカーマークとして表示される。このディスプレイ16は、例えばCRT、液晶表示素子などから構成される。また、スピーカ17からは、車両の経路に沿った誘導情報が音声により出力されると共に、本発明に係る画像処理に関連して後述の案内音声が出力される。

【0049】画像処理部18は、車両に設置される2台のCCDカメラ19a、19bからの画像信号を解析して、本実施形態に係る画像処理を行う手段である。ここで、図2を用いて、画像処理部18の構成及び動作について説明する。

【0050】図2に示すように、画像処理部18は、A／Dコンバータ21と、第1画像メモリ22と、第2画像メモリ23と、移動ベクトル検出部24と、移動ベクトル処理部25を含んで構成されている。また、画像制御部18は、制御部11からの制御信号に従って動作する。なお、画像処理部18は、実際には後述のように2台のCCDカメラ19a、19bからの画像信号を処理するが、簡単のため、一方のCCDカメラ19aからの画像信号を処理する場合を説明する。

【0051】図2において、A／Dコンバータ21は、CCDカメラ19aによって撮像された画像に基づくアナログ画像信号をディジタル画像信号に変換する。通常、A／Dコンバータ21から出力されるディジタル画像信号は、所定のフレーム周期ごとに1つのフレーム画像データを構成し、連続する複数のフレーム画像データからなる。

【0052】第1画像メモリ22及び第2画像メモリ23は、それぞれA／Dコンバータ21から出力されるフレーム画像データを格納する。第1画像メモリ22は最新のフレーム画像データを格納し、第2画像メモリ23は1つ前のフレーム画像データを格納する。よって、画像処理部18では、常に最新の2フレーム分の画像データが保持されており、これらを用いて後述の処理が行われる。

【0053】移動ベクトル検出部24は、第1画像メモリ22及び第2画像メモリ23に格納されるフレーム画像データに基づいて、画像中の各領域ごとの移動ベクトルを検出する。この際、センサ部14から出力された車速データを用いる。

【0054】また、移動ベクトル処理部25は、移動ベクトル検出部24により検出された移動ベクトルに基づいて、走行道路における道路端までの距離及びこれに基づく道幅を求め、道幅データ等として出力する。

【0055】なお、移動ベクトル検出部24と移動ベクトル処理部25における処理の詳細については後述する。

【0056】図1に戻って、CCDカメラ19a、19bは、それぞれ車両前方の両端部付近に設置され、車両の左右側方を撮像し、画像信号を出力する。ここで図3に、CCDカメラ19a、19bの車両への設置状態を示す。

【0057】図3（a）は、車両上方から見たCCDカメラ19a、19bの設置状態を示す図である。図3（a）に示すように、CCDカメラ19a、19bは車両前方側において左右両側の車体上部に取付けられている。CCDカメラ19aが車両左側に、CCDカメラ19bが車両右側にそれぞれ取付けられている。CCDカメラ19aは、車両左側の側方を向いて撮像可能に取付けられ、CCDカメラ19bは、車両右側の側方を向いて撮像可能に取付けられ、それぞれ対称的な配置で設置されている。

【0058】また、図3（b）は、CCDカメラ19aに関し、車両前方から見た設置状態を撮像範囲と共に示す図である。なお、簡単のため、車両左側の場合の撮像状態のみ示している。図3（b）に示すように、CCDカメラ19aは壁面に向かって画角θの範囲を撮像する。通常、撮像された画像には、上部の壁面が映ると共に下部に道路面が映る角度に取付けられる。本発明においては、CCDカメラ19aにより撮像された画像に基づいて、左側道路端までの距離DLを算出する。

【0059】なお、CCDカメラ19aは、車両の高さ約1mの位置に取付けられる。また、右側のCCDカメラ19bの場合は、図3（b）と対称的な撮像状態となり、右側道路端までの距離DRを算出する。

【0060】次に、本実施形態に係る画像処理の原理について、図4～図8を参照して説明する。

【0061】図4は、前述のCCDカメラ19a、19bにより撮像された画像をピンホールカメラのモデルで表した図である。図4においては、CCDカメラ19aの受光素子部に対応する画像平面P0と、レンズ部に対応する焦点面Fとが焦点距離fを隔てて平行に配置されている。焦点面Fのレンズ中心Cがピンホールに対応し、このレンズ中心Cを中心に空間座標系（X，Y，Z）を考える。一方、画像平面P0では、空間座標（0，0，－f）を画像中心cとして、カメラ座標系（x，y）を考える。

【0062】ここで、空間座標系の点M（Xm，Ym，Zm）を考える。この点Mは、例えば図３（ｂ）における壁面上の所定の位置に対応させることができる。この点Mに対する中心射影を考えると、点Mから焦点面Fのレンズ中心Cを通って画像平面Ｐ０までが直線で結ばれ、カメラ座標系の点m（xm，ym）に射影される。このとき、点M（Xm，Ym，Zm）と射影された点m（xm，ym）の関係は次式で表される。

【0063】

【数1】

$$xm = f \cdot Xm / Zm$$

$$ym = f \cdot Ym / Zm$$

次に図５は、図４に対応して、空間座標系（X，Y，Z）と画像データのピクセル座標系（u，v）の関係を表した図である。図５においては簡単のため、図４の画像平面Ｐ０を焦点面Fの前方側に配置させると共に、カメラ座標系（x，y）のx軸、y軸をそれぞれ反転させてu軸、v軸とすることにより、ピクセル画像系（u，v）としたものである。図４の配置を図５の配置に置き換えても、互いに等価であるため、同様の関係が成り立つ。

【0064】図５において、ピクセル画像系の画像平面Ｐ１は、水平方向の画素数Ｎｗと垂直方向の画素数Ｎｈの表示画像に対応しており、画像平面Ｐ１には全部でＮｗ×Ｎｈの画素が含まれる。一方、この画像平面Ｐ１は、サイズが横幅w、高さhとなるＣＣＤカメラ１９ａ、１９ｂの受光領域に一致する。そして、図４と同様に空間座標系の点M（X，Y，Z）を考えると、図５に示すように、画像平面Ｐ１の点m（u，v）を通って焦点面Fのレンズ中心Cまで直線で結ばれる。

【0065】ここで、図４と同様に、点mに対する中心射影を考えると、数１に対応して、点M（X，Y，Z）と射影された点m（u，v）の関係は次式で表される。

【0066】

【数2】

$$u = (f \cdot X / Z) \cdot Nw / w$$

$$v = (f \cdot Y / Z) \cdot Nh / h$$

すなわち、数２は、点m（u，v）の画像平面Ｐ１における画素位置を表している。数２において、uが水平方向の画素位置に対応し、vが垂直方向の画素位置に対応している。

【0067】本実施形態では、走行中の車両から撮像された画像を処理するので、画像平面Ｐ１内の物体の動きを想定する必要がある。そのため、画像平面Ｐ１におけるオプティカルフロー、すなわち移動ベクトルＶ（u，v）を求める必要がある。３次元空間の同一点の明るさＩが一定に保たれる場合、次の時空間微分方程式が成り立つ。

【0068】

【数3】

$$dI/dt = Ix \cdot u + Iy \cdot v + It = 0$$

ただし、それぞれ画像平面Ｐ１内において、Ｉｘが水平

方向の偏微分、Ｉｙが垂直方向の偏微分、Ｉｔが時間軸方向の偏微分、u、vは上述の移動ベクトルＶの水平方向、垂直方向の成分である。

【0069】次に、図６及び図７を用いて移動ベクトルＶを求める方法について説明する。図６に示すように、時刻ｔにおける画像平面Ｐ１内に参照ブロックＲを定義する。この参照ブロックＲは、左上の画素ｐｒを起点として、u軸にm画素、v軸にn画素の範囲の矩形領域であり、全部でm×n個の画素を含んでいる。そして、画像平面Ｐ１を複数の参照ブロックＲに分割し、各々の参照ブロックＲごとに移動ベクトルＶを求める。図６の例では、m＝８、n＝８となる参照ブロックＲを示している。

【0070】図７は、画像平面Ｐ１内の所定の参照ブロックＲに対する移動ベクトルＶの求め方を説明する図である。図７は、図６の時刻ｔからΔｔが経過した時刻ｔ＋Δｔにおける画像平面Ｐ１に対応する。そして、センサ部１４からの車速データ等に基づいて、画像平面Ｐ１内の所定の領域を予めサーチ範囲Ｓとして定めておく。サーチ範囲Ｓは、u軸にM画素、v軸にN画素となる矩形領域であって、通常は、M、Nがm、nに比べると十分大きくなる。

【0071】そして、サーチ範囲Ｓに対し、参照ブロックＲと同サイズの比較ブロックＣを所定の位置に定義する。サーチ範囲Ｓは参照ブロックＲに比べサイズが十分大きいため、比較ブロックＣの位置をサーチ範囲Ｓ内で少しづつ動かす必要がある。図７では、比較ブロックＣは参照ブロックＲと同様にm×nのサイズであり、参照ブロックの左上の画素ｐｒに対応する比較ブロックＣの左上の画素ｐｃを示している。最初はサーチ範囲Ｓの左上の画素を比較ブロックＣの画素ｐｃに設定し、その後はサーチ範囲Ｓの中で、u軸方向又はv軸方向に画素ｐｃの位置を１画素づつ動かして、サーチ範囲Ｓ内に定義可能な全ての比較ブロックＣについて後述の演算を行う。

【0072】次いで、図６の時刻ｔにおける参照ブロックＲと、図７の時刻ｔ＋Δｔにおける比較ブロックＣの間で相関値を求める。ここで、画素の集合である画像データでは、m×n個の全ての画素に濃度値を対応させているので、参照ブロックＲと比較ブロックＣの対応する画素ごとの濃度値の差分を求める。この濃度値の各画素ごとの差分に対し、m×n個の画素についての和をとれば、相関値を計算することができる。

【0073】そして、参照ブロックＲに対し、サーチ範囲Ｓの中の全ての比較ブロックＣとの間の相関値を求め、最小の相関値を与える比較ブロックＣを探索する。例えば、図７に示す比較ブロックＣが最小の相関値を与えるとする。

【0074】この場合は、図７に示すように、画像平面Ｐ１において、点線で示した時刻ｔにおける参照ブロッ

クRから時刻t＋Δtにおける比較ブロックCに向かうベクトルを移動ベクトルVとして決定することができる。

【0075】図7では1つの移動ベクトルVのみ示したが、実際には移動ベクトルVを、画像平面P1に定義可能な全ての参照ブロックRについて求める。これにより移動ベクトルVの空間的な分布を求める。そして、この移動ベクトルVの空間的な分布に基づいて後述の処理が行われる。

【0076】次に、図8を用いて、上記の距離DR、DL及び道幅の算出方法を説明する。図8は、CCDカメラ19aから撮像した画像における移動ベクトルVの分布の一例を示す図である。図8では簡単のため、図3（b）と同様に、車両の横方向において、道路面と壁面が境界部30にて接している場合を想定する。また、時刻tにおけるラインL1上の移動ベクトルVの分布を考える。

【0077】図8に示すように、CCDカメラ19aにて撮像された画像において、境界部30の上部にある壁面では移動ベクトルVの大きさが一定値となっているのに対し、境界部30の下部にある道路面では移動ベクトルVの大きさが略一定の変化率で変化している。このように、移動ベクトルVの大きさは、撮影対象物までの距離zに依存した値となる。

【0078】すなわち、速度v0（m／秒）で走行している車両において、フレーム周期TでCCDカメラ19aによる撮像を行うとすると、1フレーム間の車両の移動距離dは、

【0079】

【数4】$d = v0 \cdot T\ (m)$

と表すことができる。ここで、撮影対象物は車両と相対的にu方向にのみ動き、v方向及びz方向に動かない状況を考えると、上述の数2にx＝dを代入すればよく、以下の式が成り立つ。

【0080】

【数5】$u = (f \cdot d / z) \cdot Nw / w = (f \cdot v0 \cdot T / z) \cdot Nw / w$

と表すことができる。数5に示すuにより移動ベクトルV（u、0）が定まり、このuは移動ベクトルVの大きさに一致する。このように、移動ベクトルVの大きさは、撮影対象物との距離zと反比例する。

【0081】図9は、ラインL1の移動ベクトルVの大きさが、数5に対応して変化する様子を示す図である。図9においては、図8の画像中のv軸に対し、撮影対象物の移動ベクトルの大きさを実線で示すと共に、距離zを点線で示している。図8から判るように、壁面では距離zが一定となるため、移動ベクトルVの大きさも一定となる。これに対し、道路面では距離zが下方にいくほど略一定の割合で小さくなるので、数5のuは直線的に大きくなっていく。

【0082】従って、図9において、移動ベクトルVが略一定の変化率で変化せず、概ね一定となるか否かに基づいて、壁面と道路面を区別することができ、境界部30の位置も判断することができる。そして、壁面の移動ベクトルVの平均値をMV（ピクセル）とすれば、上記の壁面までの距離DLは、数5に基づいて、

【0083】

【数6】

$$DL = (f \cdot v0 \cdot T / MV) \cdot Nw / w$$

を算出して求めることができる。

【0084】なお、道路端に溝部が存在する場合は、道路面では画像の上方に行くにつれ略一定の変化率で移動ベクトルVが小さくなるが、道路面と溝部の境界では部分的に変化率が一定ではなく急激に変化する。よって、この不連続点を判別することで溝部を検出し、その前後の移動ベクトルVの大きさに基づき道路端までの距離DLを求めることができる。

【0085】また、単一の壁面ではなく、例えばガードレールのように部分的な壁面となる場合は、移動ベクトルVが概ね一定となる複数の領域が生じる可能性があるが、上述のように不連続点を検出すると共に、複数の領域についての距離DLを求め、そのうち最短となる距離DLを用いればよい。道路端にガードレールが隣接する場合も、ガードレールに対応する領域までの距離に基づいて、道路端の距離DLを求めることができる。

【0086】なお、数5における各数値の具体例としては、焦点距離f＝4（mm）、水平方向の画素数Nw＝320（ピクセル）、受光領域の横幅w＝4（mm）、フレーム周期T＝1／30（秒）程度になる。

【0087】以上の画像処理を、2つのCCDカメラ19a、19bによる画像に対し同様に行えば、車両の左右における道路端までの距離DL、DRが求められる。よって、これらを加えると共に、更に車両の横幅を考慮して、走行中の道路における道幅を算出することができる。例えば、図2（b）の設置状態において車両が横幅Wを有するとき、道幅RWは、

【0088】

【数7】$RW \fallingdotseq DL + DR + W$

と近似的に求めることができる。

【0089】なお、算出された道幅RWに対応する道幅データを地図データと関連づけて道幅データ記憶部13に更新可能に記憶すれば、後述の各種の処理に利用することができる。

【0090】次に、本実施形態に係るナビゲーション装置における具体的な画像処理に関し、図10及び図11を参照して説明する。図10は、走行中の車両が道路端に近接するのを防止するための処理を示すフローチャートであり、図11は、複数車線の道路を走行中の車両が設定経路に対し適正な車線を走行させるための処理を示すフローチャートである。なお、図10及び図11は、

主に制御部１１の制御に従って行われる処理である。

【００９１】図１０に示す処理が開始されると、上述のような画像処理部１８の処理により、両側の道路端までの距離ＤＬ、ＤＲが求められ、これに基づき数７に従って道幅ＲＷが算出される（ステップＳ１）。そして、ステップＳ１にて算出された道幅ＲＷに対応する道幅データは、地図データと関連づけられて道幅データ記憶部１３に書き込まれる（ステップＳ２）。このとき、予め設定された道路上の所定のポイントにおいて、道幅データの書き込みを行うようにしてもよい。

【００９２】次いで、ステップＳ１において得られた距離ＤＬ、ＤＲに基づいて、走行中の車両が道路端に寄り過ぎているか否かが判断される（ステップＳ３）。すなわち、基準となる所定の距離を設定しておき、距離ＤＬ又はＤＲがこの所定の距離より小さい値となる場合は、車両が道路端に寄り過ぎであると判断すればよい。

【００９３】ステップＳ３の判断結果が「ＹＥＳ」である場合、車両が道路端に寄り過ぎであることをドライバーに警告する（ステップＳ４）。例えば、道路端に寄り過ぎである旨を示す所定のメッセージを、スピーカ１７から音声として出力すればよい。あるいは、同様のメッセージ又は表示記号等をディスプレイ１６に表示してもよい。

【００９４】ステップＳ３の判断結果が「ＮＯ」である場合、あるいはステップＳ４を終えると、車両が走行中であるか否かを判断する（ステップＳ５）。車両が走行中でない場合（ステップＳ５；ＮＯ）、画像処理を行う必要がないので処理を終える。一方、車両がまだ走行中である場合（ステップＳ５；ＹＥＳ）、ステップＳ１〜ステップＳ５の処理を繰り返す。

【００９５】ナビゲーション装置において、以上のステップＳ１〜ステップＳ５の処理を行うことにより、常に正確な道幅ＲＷをリアルタイムに求めることができる。そして、道路端までの距離ＤＬ、ＤＲを監視し、走行中の車両が道路端に寄り過ぎた時に、ドライバーに警告を行うようにしたので、ドライバーの運転を補助して走行中の安全を確保することができる。また、道幅データを道幅データ記憶部１３に適宜に書き込むようにしたので、後に同じ道路を走行する場合、有効に道幅データを活用することが可能となる。

【００９６】次に、図１１に示す処理は、ナビゲーション装置に所望の目的地が設定され、経路が判断される状況下にて行われる。まず、ステップＳ１と同様にして、両側の道路端までの距離ＤＬ、ＤＲが求められ、更に道幅ＲＷが算出される（ステップＳ１１）。

【００９７】そして、地図データ記憶部１２の地図データに含まれる走行中の車線に対する車線情報を読み出す（ステップＳ１２）。この車線情報は、走行中の道路が何車線であるを示す情報であるため、車線情報に基づき走行中の道路が複数車線であるか否かを判断する（ステップＳ１３）。

【００９８】ステップＳ１３の判断結果が「ＹＥＳ」である場合、ステップＳ１１の判断結果に基づいて、複数車線のうち現在どの車線を走行中であるかを判定する（ステップＳ１４）。この判定は、ステップＳ１にて求めた車両の両側の道路端までの距離ＤＬとＤＲとの比に基づいて行うことができる。

【００９９】続いて、ステップＳ１４で判定された車線が、目的地に達する経路に対応して適正な車線であるか否かを判断する（ステップＳ１５）。すなわち、例えば３車線の道路を走行している場合を例にとると、一般的には前方で右折するときは右側の車線が適正となり、前方で左折するときは左側の車線が適性となり、そのまま直進するときは何れの車線であってもよいことになる。あるいは予め左折、右折時の適正車線の情報を設定しておいてもよい。

【０１００】ステップＳ１５の判定の結果、車両が適正な車線を走行している場合は（ステップＳ１５；ＹＥＳ）処理を終える。一方、車両が適正ではない車線を走行している場合は（ステップＳ１５；ＮＯ）、ドライバーに車線変更の案内を指示する（ステップＳ１６）。例えば、右折ポイントの手前で左側の車線を走行している場合、もう２車線右に移動することをドライバーに促す旨のメッセージを、スピーカ１７から音声として出力し、あるいはディスプレイ１６に表示すればよい。

【０１０１】ナビゲーション装置において、以上のステップＳ１１〜ステップＳ１６の処理を行うことにより、複数車線の道路において車両が位置する車線をリアルタイムに判定することができる。そして、右折や左折等を行うために適正な車線に位置しない場合のみ、ドライバーに車線変更の案内を行うようにしたので、必要な場合のみ案内が行われ、既に適正な車線を走行している場合は、不要な案内が行われずに済む。そのため、利便性が高く、ドライバーにとって一層快適なナビゲーションが実現可能となる。

【０１０２】なお、図１１の例では、車両が適正ではない車線を走行しているときにのみ車線変更の案内を指示する場合、すなわち、適正な車線を走行しているときに車線変更の案内を指示しない場合を説明したが、これに限られず、車両が適正な走行しているとき、何らかの案内を行うようにしてもよい。例えば、適正な車線を走行中に、「このままの車線を維持して下さい」などの案内を音声等により出力してもよい。これにより、運転中のドライバーに適正な車線を走行していることを把握させて安心感を与えることができる。

【０１０３】以上、実施形態に基づき本発明を説明したが、本発明は上記実施形態に何ら限定されるものではなく、本発明の趣旨を逸脱しない範囲内で種々の改良変形が可能であることは容易に推察できるものである。

【０１０４】例えば、撮像手段としてのＣＣＤカメラ１

9a、19bにより撮像した画像をディスプレイ16に表示するようにしてもよい。本実施形態では、CCDカメラ19a、19bが車両前方において真横方向を撮像するように設置されているため、ドライバーが側方を直接見ることができる位置に達する前に、ディスプレイ16にて側方画像を視認することできる。特に、車両が狭い路地から交差点に進入する場合などは、車両先端を僅かに交差点に出すだけで側方画像を視認でき、車両の安全走行に有用となる。

【0105】また、上記実施形態では、撮像手段としてのCCDカメラ19a、19bが車両の側方における真横方向を撮像するように設置されている場合を説明したが、これに限られず、車両の側方における斜め前寄り方向を撮像するように設置してもよい。これにより、側方画像を時間的に先行して処理することができ、タイムリーに道路端までの距離を求めることができる。

【0106】あるいは、CCDカメラ19a、19bを車両の側方における斜め下寄り方向を撮像するように設置してもよい。一般に、垂直方向の画角が狭いCCDカメラ19a、19bを用いると、車両が道路端に近接したときに道路端が画像内に入らなくなる場合が生じる。このような場合であっても、CCDカメラ19a、19bの撮像方向が下寄りであれば、道路端が画像内に入るので、道路端までの距離を求めることが可能となる。

【0107】また、より広い画角を有するCCDカメラ19a、19bを用いてもよい。例えば、水平方向の画角が180度近くあるCCDカメラ19a、19bを用い、それぞれの撮像画像における左側の領域と右側の領域に対し別個に上述の処理を行うことにより、道路端までの距離を求めてもよい。これにより、一層きめ細かく道路端までの距離を求めることができる。

【0108】

【発明の効果】以上説明したように、本発明によれば、撮像手段により走行中の車両の側方を撮像し、画像処理を行って道路端までの距離を求めるようにしたので、走行車両の安全確保や道幅データの取得など、車両の安全性と利便性を高めることが可能となる。

【0109】また、本発明をナビゲーション装置に適用すれば、車両の道路端近接時のドライバーへの告知、車線判定に基づく車線変更の告知、道幅データの記憶などにより、ナビゲーション装置を支援して機能向上を図ることが可能となる。

【図面の簡単な説明】

【図1】本実施形態に係るナビゲーション装置の概略構成を示す図である。

【図2】ナビゲーション装置の画像処理部の構成を示す図である。

【図3】CCDカメラの車両への設置状態を示す図であり、（a）は車両上方から見た設置状態、（b）は車両前方から右側の設置状態をそれぞれ示す図である。

【図4】CCDカメラにより撮像された画像をピンホールカメラのモデルで表した図である。

【図5】空間座標系と画像データのピクセル座標系の関係を表した図である。

【図6】移動ベクトルを求める際に画像平面内に定義する参照ブロックについて説明する図である。

【図7】画像平面内の所定の参照ブロックに対し、サーチ範囲内に比較ブロックを定義して、移動ベクトルを求める方法を説明する図である。

【図8】本実施形態に係る画像処理において、道路端までの距離及び道幅の算出方法を説明する図である。

【図9】画像内の移動ベクトルの大きさ及び壁面との距離が変化する様子を説明する図である。

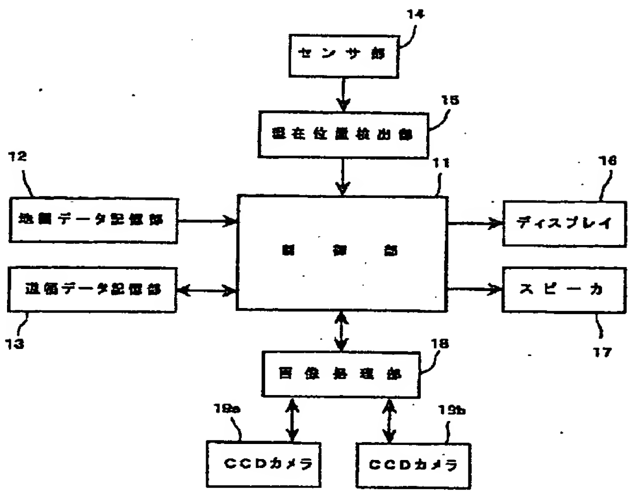
【図10】本実施形態に係るナビゲーション装置において、道幅検出に対応して、走行中の車両が道路端に近接するのを防止するための処理を示すフローチャートである。

【図11】本実施形態に係るナビゲーション装置において、道幅検出に対応して、複数車線の道路を走行中の車両が設定経路に対し適正な車線を走行させるための処理を示すフローチャートである。

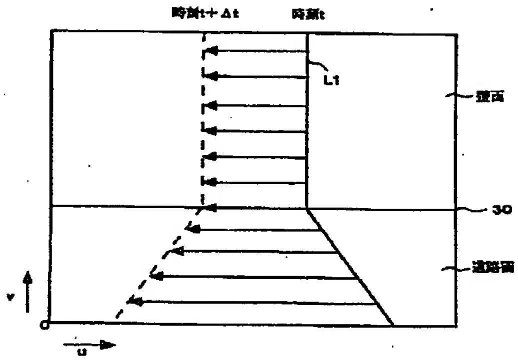
【符号の説明】

11…制御部
12…地図データ記憶部
13…道幅データ記憶部
14…センサ部
15…現在位置検出部
16…ディスプレイ
17…スピーカ
18…画像処理部
19a、19b…CCDカメラ
21…A／Dコンバータ
22…第1画像メモリ
23…第2画像メモリ
24…移動ベクトル検出部
25…移動ベクトル処理部

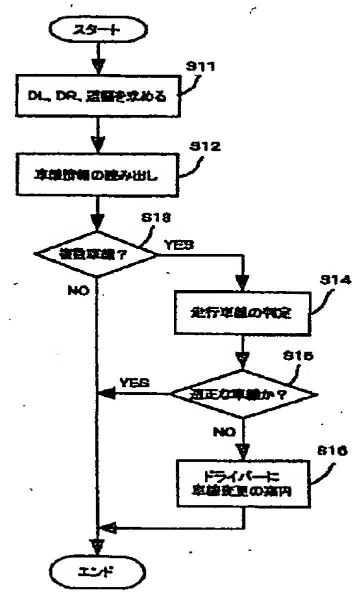
【図1】



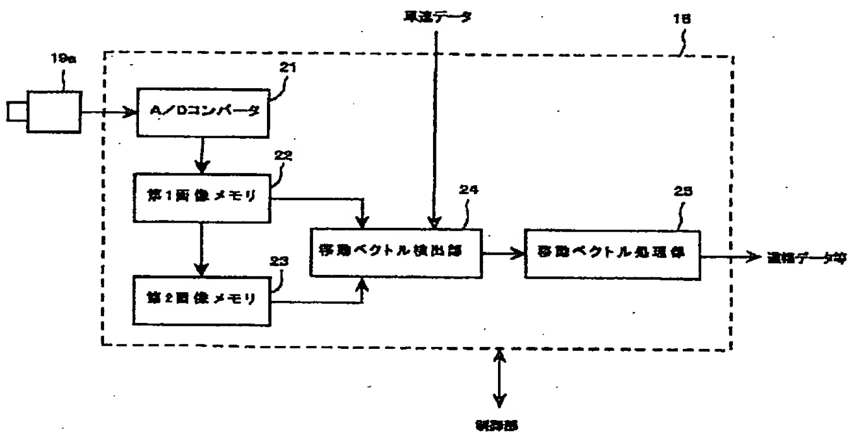
【図8】



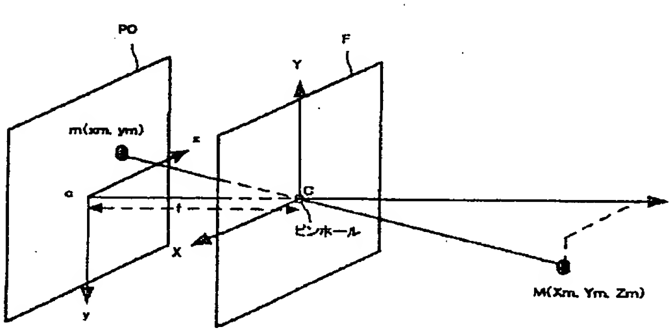
【図11】



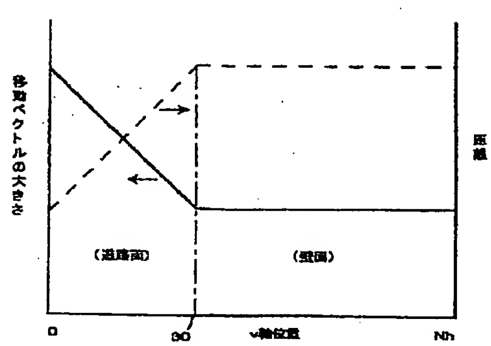
【図2】



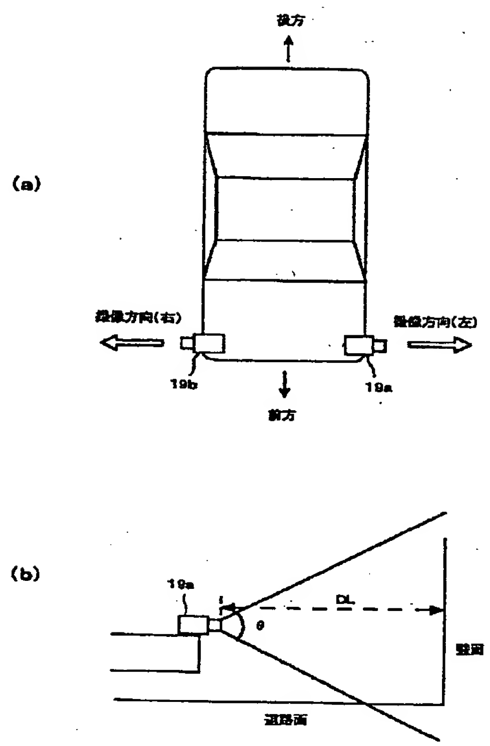
【図4】



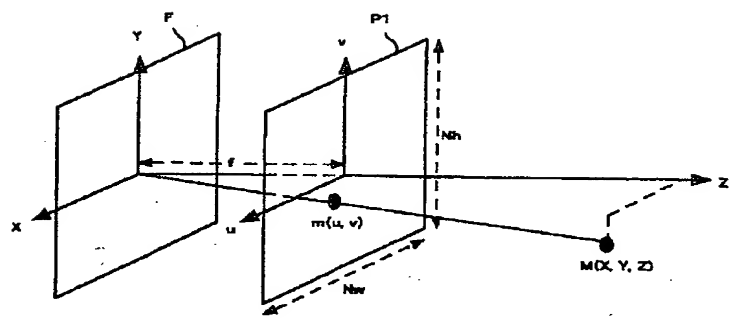
【図9】



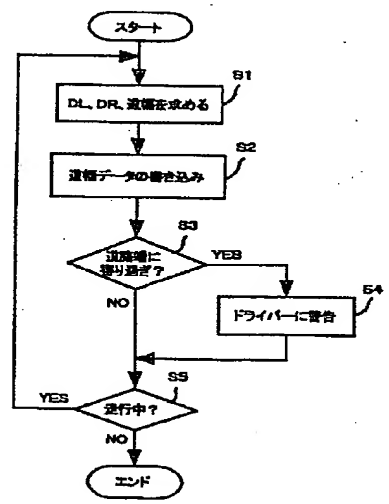
【図3】


後方
(a)
撮像方向(右)
撮像方向(左)
19b
19a
前方
(b)
19a
DL
θ
壁面
道路面

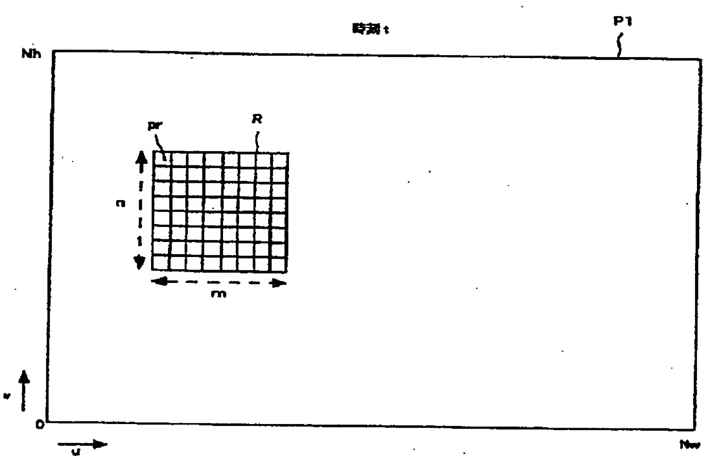
【図5】


F
Y
P1
v
Nh
f
Z
X
u
m(u, v)
M(X, Y, Z)
Nw

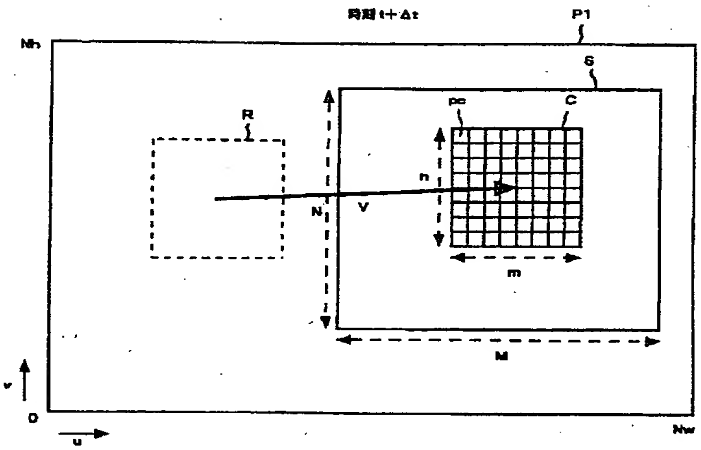
【図10】


スタート
S1
DL, DR, 道幅を求める
S2
道幅データの書き込み
S3
道路端に寄り過ぎ？
YES
S4
ドライバーに警告
NO
S5
YES
走行中？
NO
エンド

【図6】


時刻t
P1
Nh
pr
R
n
m
v
0
u
Nw

【図7】



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G08G	1/04		G08G	1/16	C	
	1/16		G06F	15/70	410	

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AC04 AC09 AC14 AC18
2F065 AA06 AA12 AA22 BB13 CC40
FF04 FF09 FF63 FF64 FF67
JJ03 JJ05 JJ08 JJ26 PP01
QQ00 QQ03 QQ13 QQ24 QQ25
QQ26 QQ27 QQ28 QQ41 SS03
SS09 SS13
2F112 AD05 AD10 BA18 CA05 FA03
FA07 FA21 FA27 FA41
5H180 AA01 BB13 CC04 FF04 FF05
FF22 FF25 FF27 FF33 LL02
LL07 LL08
5L096 BA04 CA04 DA02 EA23 FA34
FA54 FA66 GA08 GA28 HA04